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AFOSR Mission Critical STEAM Program

MISHA LESLEY

THURGOOD MARSHALL COLLEGE FUND

02/10/2014
Final Report

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14. ABSTRACT

Consistent with the Department of Defense Air Force Office of Scientific Research (AFOSR) diversity and inclusion goals, Thurgood Marshall College Fund (TMCF) has aligned its programmatic activities to address workforce diversity priorities by contributing to the agency in three critical areas: research, higher education, and industry. Specifically, TMCF has devised a cost effective recruitment and capacity-building strategy that will (1) increase the research capaciy of underrepresented groups; (2) improve TMCF's member-schools' abilitiy to attract, retain and graduate science, technology, engineering, agriculture and mathematics (STEAM) students; and (3) identify and prepare a qualified STEAM and STEM workforce.

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ABSTRACT

Consistent with the Department of Defense Air Force Office of Scientific Research (AFOSR) diversity and inclusion goals, TMCF has aligned its programmatic activities to address the workforce diversity priorities of AFOSR by contributing to the agency in three critical areas: research, higher education, and industry. Specifically, TMCF has devised a cost-effective **recruitment** and **capacity building** strategy that will (1) increase the research capacity of underrepresented groups; (2) improve TMCF member-schools' ability to attract, retain and graduate science, technology, engineering and mathematics (STEM) students; and (3) identify and prepare a qualified STEM workforce.

The Thurgood Marshall College Fund (TMCF) is the only national organization to provide merit scholarships, programmatic support, and capacity building to the nation's 47 *public* Historically Black Colleges and Universities (HBCUs). To date, TMCF has provided nearly $200 million in support of students and member schools. TMCF member schools are a critical source of higher education for all students. More than 80% of all students enrolled in HBCUs attend TMCF member-schools.

TMCF leveraged its 26 year relationship with its 47 member-schools to (1) identify, develop and on-board HBCU students for workplace leadership roles, and (2) build TMCF member-schools' capacity to graduate STEM students and expand STEM research

ANNUAL ACCOMPLISHMENTS

I. Training, Development and Placement

TMCF's training, development and placement activities, which included the annual Leadership Institute, summer internships and K-12 teacher preparation to address the AFOSR's aim to support the preparation of students who will be equipped for STEM careers in government and industry.

Leadership Institute

The TMCF Leadership Institute is one of the premier programs of its type in the nation. Since 2000, TMCF in partnership with its 47-member public HBCUs, selects top performing students (juniors, seniors and graduate students) to attend the Institute held in New York City and scheduled to be held in Washington, D.C. in 2013. In 2012, 484 students participated, of whom 31.6 percent were STEM majors. Students participated in workshops, seminars, recruitment events and interviews. Topics addressed include global leadership development and career development training.

During this conference, the DOD AFOSR professionals have the opportunity to interact with the many students attending to provide them with information on job opportunities with the Defense

Department. DOD AFOSR representatives can help students more fully appreciate the importance of producing a competitive workforce with an expertise in STEM fields.

In addition, students receive training in career development fundamentals for transitioning to the professional workplace. These fundamentals include:

- Financial Literacy
- Global Leadership
- Soft Skills
- Personal Branding

Summer Internships

TMCF managed a summer internship program with various DOD AFOSR agencies to provide placement of STEM students. TMCF will provided a turn-key internship solution that included recruiting, screening, hiring, administering payroll, transporting, housing, and managing the students internship experience.

Overview

TMCF identified and placed 29 pre-screened HBCU students (interns) to work in short-term and long-term employment opportunities in an effort to increase the representation of minorities pursing careers in STEM.

The internship provided for students the opportunity to engage in scientific and engineering (S&E) and research and development (R&D) efforts, which would not be otherwise available in an educational environment (the Internship).

Recruitment

TMCF opened the application window using its online recruitment tool and sourced candidates through a number of outlets. Using faculty and administration contacts at the 47-member school network, social media sites (Facebook, Twitter, and LinkedIn) and email blasts. Approximately 188 students applied.

Participant Demographics

Interns began on June 3, 2013 and completed their internship on August 9, 2013. Twenty-nine (29) interns were placed, representing fourteen (14) of the forty-seven (47) TMCF member-schools. The students' majors represented STEM and business fields., Interns included one (1) sophomore, ten (10) juniors, fifteen (15) seniors, two (2) graduates and one (1) doctoral student. There were fourteen (14) female and fifteen (15) males. The average grade point average was 3.45 on a 4.0 scale. Please see the list of selected interns below:

First Name	Last Name	Major	GPA	Classification
Kierston	Moorer	Computer Science	3.75	Sophomore
Kheri	Hicks	Computer Science & Mathematics	3.43	Senior
Lomiesha	Paul	Chemistry	3.59	Senior
Tiesha	Donigan	Computer Science and Mathematics	3.34	Senior
Deja	Knight	Computer Science Program	3.61	Senior
Poyuk	Cheung	Mathematics	3.8	Senior
Shakema	Gailliard	Accounting	3.76	Senior
Keaundra	Harris	Accounting	3.65	Senior
Keith	Williams	Mechanical Engineering	3.26	Senior
Cornelius	Myles	Mathematics and Computer Science	3.87	Senior
Benjamin	Osoba	Electronics Engineering	3.92	Senior
Joshua	Lee	Biomedical Engineering	3.56	Senior
Darvis	Simms	Electrical Engineering	2.7	Senior
Elisha	Wilson	Nuclear Engineering	2.85	Senior
Joseph	Reynolds	Electrical Engineering Technology	2.5	Senior
Mark	Tiller	Mechanical Engineering Technology	2.9	Senior
Shabrasia	Woodard	Computer Science	3.5	Junior
Shanyce	Stewart	Engineering Technology	3.28	Junior
M'Heeraw	Kennedy	Mechanical Engineer	3.29	Junior
Donyai	Moffatt	Aviation Science	3.6	Junior
Altony	Hall	Mathematics	3.67	Junior
Keonte	Turner	Biology - Pre Med	3.29	Junior
Corbett	Clark	Biology & Psychology	3.25	Junior
Devin	Frederick	Computer Science	3.26	Junior
Michael	Johnson	Computer Science	3.8	Junior
Tre	Addison	Computer Science	3.6	Junior
Shanah	Sharpe	Mathematics	3.6	Graduate/Master's
Teya	Everett	Political Science and Criminal Justice	3.8	Graduate/Master's
Tasha	Adams	Optical Engineering	3.7	Doctoral

Barriers

Over the past several years TMCF has partnered with government agencies to implement and administer internship programs. Each year improvements are made to the program based on previous AFRL supervisor feedback. This year a few barriers arose during the first quarter of the project, which included:

- Locating housing options in remote and rural locations (Warner Robins, GA). TMCF encountered issues when attempting to secure internship housing due to the extent of stay. Most housing facilities in Warner Robins requires a minimum six (6) month lease agreement.

- TMCF experienced a lapse of communication with the point of contact (POC) at Warner Robins. During the applicant screening/interview process the POC became nonresponsive. For the sake of time, Justin Lee from Eglin AFB made the executive decision to move the already assigned interns to Wright-Patterson AFB and forfeit the last intern selection; leaving the program with a 29 intern total instead of the planned thirty.

Technology

TMCF leveraged technology to automate the HR process . The old way of onboarding a new employee is resource intensive, time consuming and expensive. With the help of the JobScience technology platform, TMCF posted and processed applications, scheduled interviews and set-up payroll in less than three weeks. JobScience saved hundreds of man-hours, which translates into thousands of dollars.

Preparing HBCU STEM Students to Teach in K-12 Classrooms

TMCF recruited, selected and trained education and STEM majors (Fellows) to participate in a one-week Teacher Quality and Retention Program Summer Institute. The Institute was facilitated by veteran master mathematics and science teachers, as well as veteran National Board Certified Teachers. The training is based on the National Math and Science Initiative's (NMSI) UTeach program, which prepares STEM majors to become certified mathematics and science teachers.

Texas Southern State University (STEM)
TXSU STEM

This section presents the results of: (1) the demographic and academic characteristics of Fellows who participated in the Texas Southern University STEM Summer Institute and (2) Fellows' perceptions of their teaching knowledge and skills of teaching.

Recruitment

A total of 25 Fellows from TMCF's member-school network were recruited for the STEM Summer Institute (21 females, 84% and 4 males, 6%). All are currently enrolled in STEM majors at their respective colleges or universities The academic status of the Fellows was quite varied: 15 at the undergraduate level, 7 at the graduate/Masters level.

Pre-Assessment of Knowledge

Twenty-five Fellows completed the pre-assessment measure and twenty-two completed the post-assessment measure. On the pre-assessment, the majority of respondents reported that they had

some knowledge of the following teaching-related strategies: Classroom Management, State Standards, Differentiated Instruction, Lesson Objectives, Classroom Teaching, Technology and Common Core Standards. On the post-assessment the majority of respondents rated their knowledge as "extremely well" for all the teaching-related variables.

Analysis of statements Fellows made about their knowledge of these teaching-related variables at the conclusion of their STEM Institute experience indicates that the majority of them had a more comprehensive understanding of teaching-related strategies in mathematics and science than prior to their participation in the STEM Institute. These positive results suggest that the summer intervention had a positive impact on the Fellows knowledge of teaching-related strategies.

Institute Experience

Analysis of Fellows' reflections of their experiences during the first and last session of the first week of the Summer Institute indicates that, in general, they made positive statements about what they learned about research-based teaching practices, practices they planned on applying to their own classrooms and the ones that thy believed would make an immediate impact on student achievement.

Post-Assessment of Knowledge

Table I below presents the means and standard deviation (SDs) of the overall ratings of the pre and post assessments as well as the ratings of the seven teaching-related strategies: Classroom Management, State Standards, Differentiated Instruction, Lesson Objectives, Classroom Teaching, Technology and Common Core Standards. The results indicate that, on average, Fellows' overall knowledge changed from pre to post assessments as well as their knowledge of specific teaching- related strategies.

Table I
Pre-Assessment means and standard deviation (SDs)-TXSU STEM

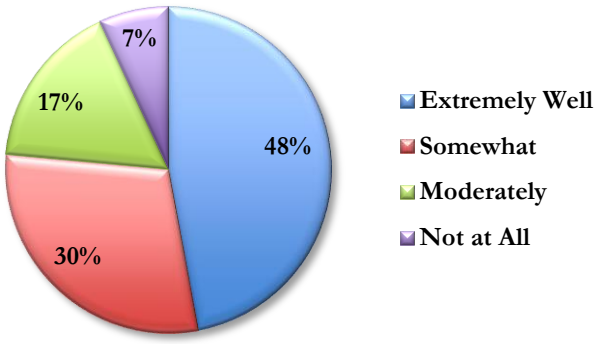
Pre and Post Assessment	Mean	N	Std. Deviation
Pre assessment – total	2.6864	22	.70325
Post assessment-total	3.2545	22	.71629
Classroom management pre ass.	3.1636	22	.86550
Classroom management post ass.	3.6909	22	.50039
Curriculum Standards- pre ass.	2.3955	22	.90526
Curriculum Standards –post ass.	3.0909	22	.85963
Differentiated Instruction-pre ass.	2.9545	22	.93591
Differentiated Instruction-post ass.	3.5545	22	.57877

Lesson objectives-pre ass.	2.7238	22	.82819
Lesson objectives- post ass.	3.5048	22	.57138
Classroom teaching-pre ass.	2.9700	22	.83924
Classroom teaching- post ass.	3.5700	22	.49535
Technology- pre ass.	2.6900	22	.89789
Technology -post ass.	3.4200	22	.58723
Common Core Standards –pre ass.	1.9800	22	.73528
Common Core Standards – pre ass.	3.0650	22	.77342

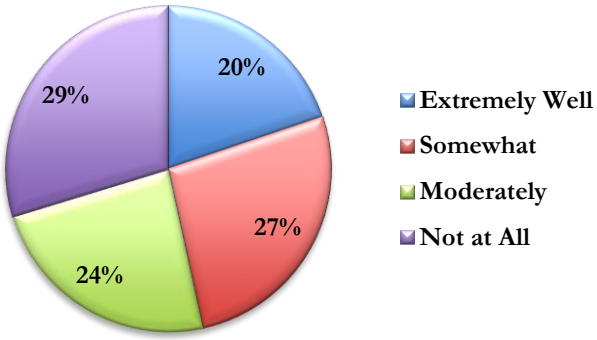
A paired sample T-test was also performed to determine if the differences in the pre and post assessment total and specific ratings were significant. A paired sample T-test was used because the assessment responses were obtained from the same subjects (i.e. STEM Summer Institute Fellows) under two conditions: (1) prior to the start of the institute and (2) after the completion of the Institute. The results showed that the difference between the total pre and post assessment ratings means was significant. On average, the post-assessment ratings ($M = 3.25$, $SD = 0.71$) are higher than the pre-assessment ratings ($M = 2.68$, $SD = 0.70$), $t = -2.824$ $df = 21$, $p < .0.05$. Moreover, the difference in the pre and post-assessment ratings was significant for the following teaching-related elements. Classroom Management: $t = -2.822$, $df = 21$, $p < .0.05$; State Standards, $t = -2.996$, $df = 21$, $p < .0.01$; Differentiated Instruction: $t = -2.628$, $df = 21$, $p < 0.05$; Lesson Objectives: $t = -3.963$, $df = 20$, $p < .0.01$; Classroom Teaching: $t = -2.924$, $df = 19$, $p < 0.01$; Technology: $t = -3.667$, $df = 19$, $p < 0.01$; and Common Core Standards: $t = -4.990$, $df = 19$, $p < 0.01$. In addition, Figure 1 shows a summary of the Fellows' knowledge in various teaching areas prior to the Institute, and Figure 2 shows a summary of the Fellows' knowledge after the Institute.

Figure 1. Summary Ratings of Fellows' Perceptions of Teaching Prior to Summer Institute TXSU STEM

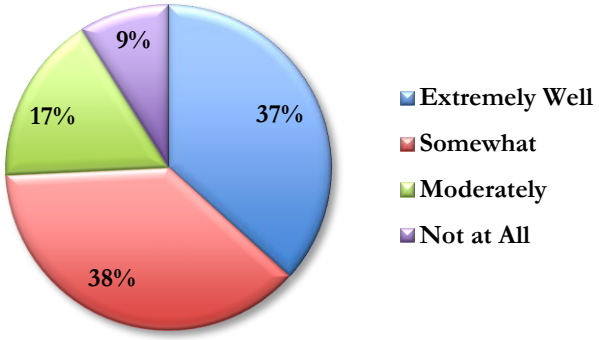
a. Knowledge of Classroom Management



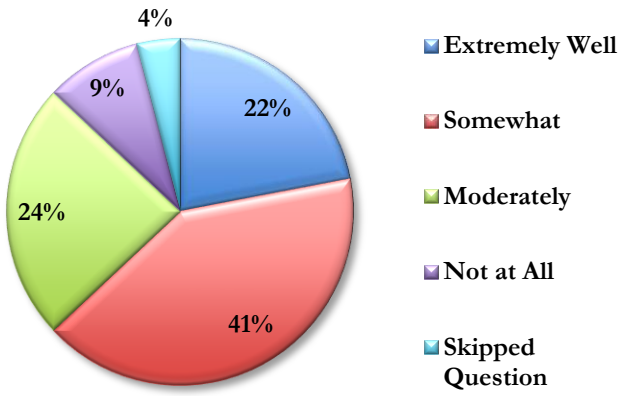
b. Knowledge of Classroom Standards



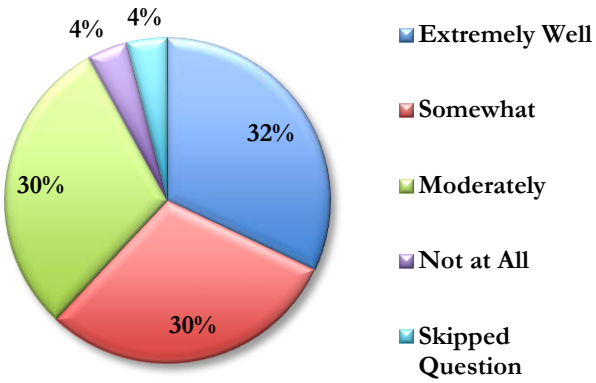
c. Knowledge of Differentiated Instruction



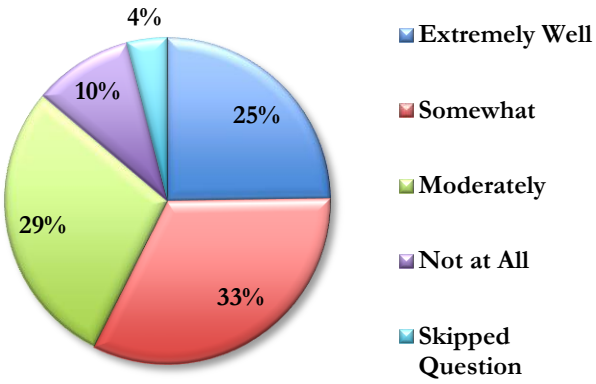
d. Knowledge of Lesson Objectives



e. Knowledge of Classroom Teaching



f. Knowledge of Technology



g. Knowledge of Common Core Standards

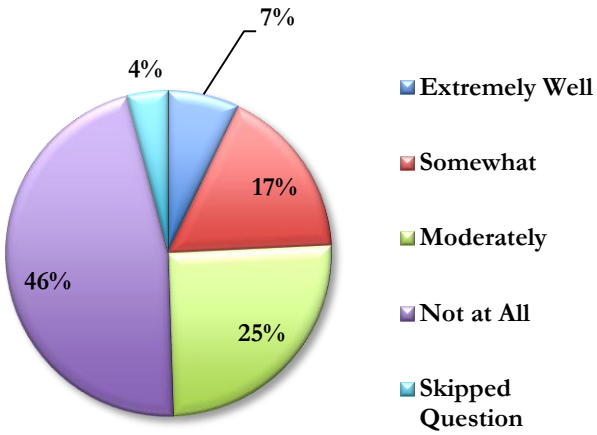
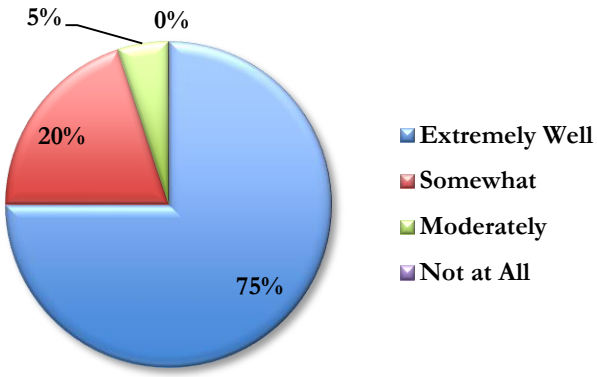
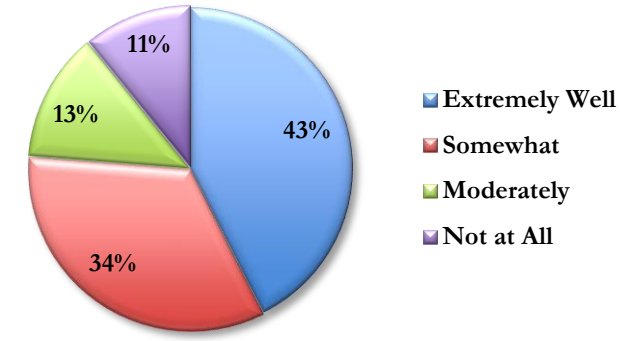


Figure 2. Summary Ratings of Fellows' Perceptions of Teaching after Summer Institute TXSU STEM

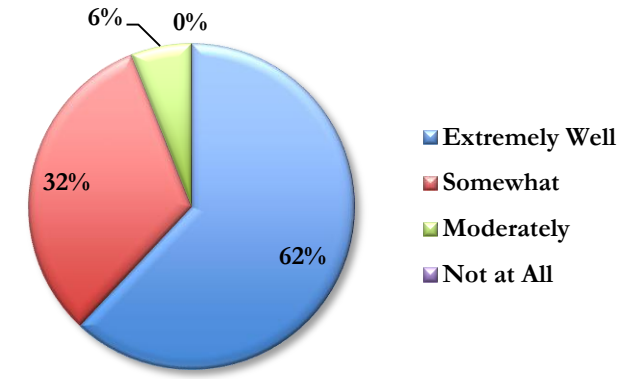
a. Knowledge of Classroom Management



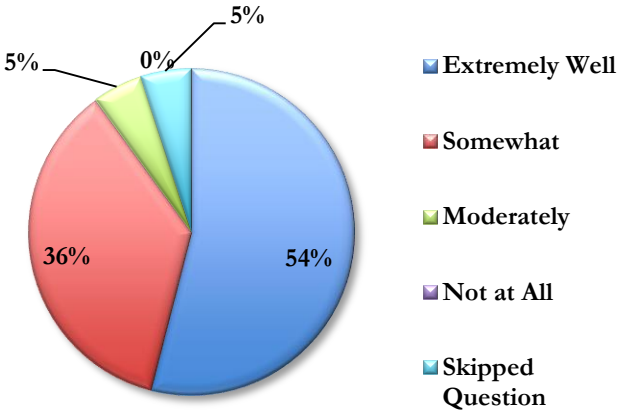
b. Knowledge of Classroom Standards



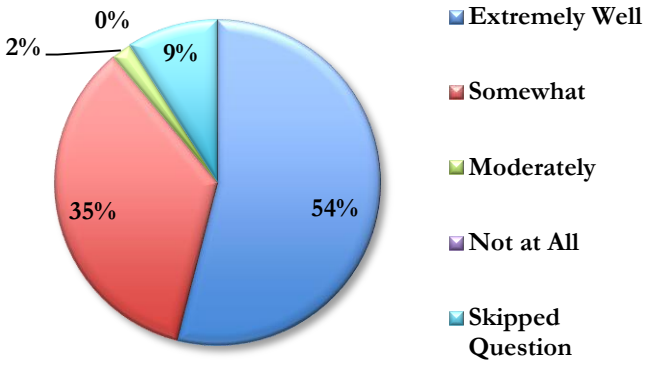
c. Knowledge of Differentiated Instruction



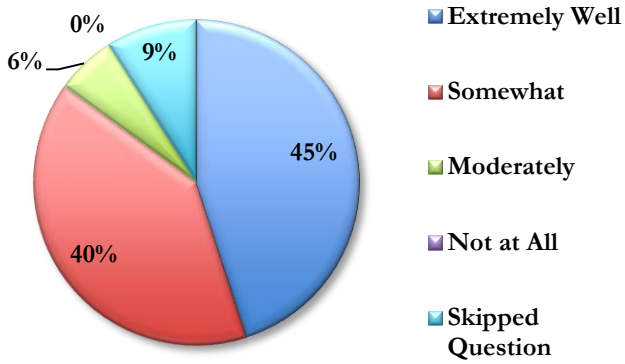
d. Knowledge of Lesson Objectives



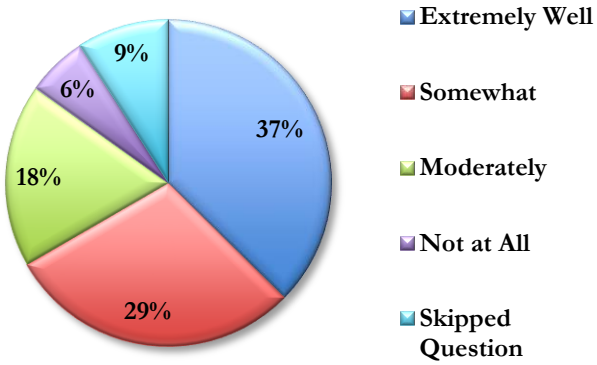
e. Knowledge of Classroom Teaching



f. Knowledge of Technology



g. Knowledge of Common Core Standards



Texas Southern State University
TXSU New Teachers

This section presents the results of: (1) the demographic and academic characteristics of Fellows who participated in the Texas Southern University New Teachers Summer Institute, and (2) Fellows' perceptions of their knowledge and skills of teaching.

Recruitment

A total of 20 Fellows were recruited for the New Teachers Summer Institute (14 females, 70% and 6 males, 30%; 13 teachers, 2 seniors and 5 gradate/Masters candidates). Fellows attended HBCUs, the majority of whom were education majors.

Pre-Assessment Results

Twenty new teachers completed the pre-assessment measure and eighteen completed the post-assessment measure. On the pre-assessment, the majority of respondents rated "extremely well" their knowledge of Classroom Management, State Standards, Differentiated Instruction, and Technology but rated "somewhat" their knowledge of Lesson Objectives, Classroom Teaching and Common Core Standards. On the post-assessment the majority of respondents rated their knowledge as "extremely well" for all the teaching-related strategies.

Table II below presents the means and standard deviation (SDs) of the overall ratings of the pre and post assessments as well as the ratings of the seven teaching-related strategies: Classroom Management, Curriculum Standards, Differentiated Instruction, Lesson Objectives, Classroom Teaching, Technology and Common Core Standards. The results indicate that, on average, Fellows' overall knowledge changed from pre to post assessments as well as their knowledge of specific teaching- related strategies.

Table II
Means and standard deviation (SDs)-TXSU New Teachers

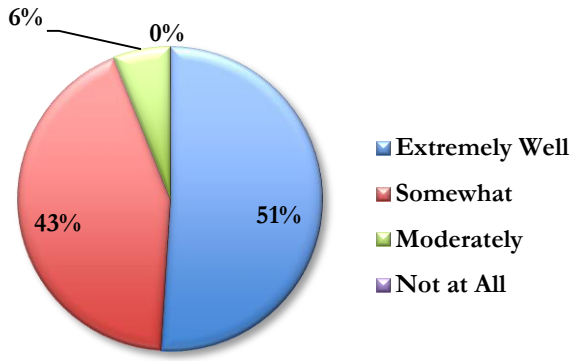
Pre and Post Assessment	Mean	N	Std. Deviation
Pre assessment – total	2.9881	16	.91209
Post assessment-total	3.4500	16	1.01956
Classroom management pre ass.	3.4533	15	.46884
Classroom management post ass.	3.6933	15	.56501
Curriculum Standards- pre ass.	2.6367	15	.51823
Curriculum Standards –post ass.	3.8060	15	.42107
Differentiated Instruction-pre ass.	3.4267	15	.57998
Differentiated Instruction-post ass.	3.8267	15	.38446
Lesson objectives-pre ass.	3.3857	14	.66778
Lesson objectives- post ass.	3.6571	14	.50492
Classroom teaching-pre ass.	3.3143	14	.65027
Classroom teaching- post ass.	3.6571	14	.50492
Technology- pre ass.	3.6857	14	.60620
Technology -post ass.	3.700	14	.63124
Common Core Standards –pre ass.	2.7385	13	.94652
Common Core Standards – pre ass.	3.5846	13	.61893

A paired sample T-test was also performed to determine if the differences in the pre and post assessment totals and specific ratings were significant. A paired sample T-test was used because the assessment responses were obtained from the same subjects (i.e. New Teachers Summer Institute Fellows) under two conditions: (1) prior to the start of the Institute and (2) after the completion of the Institute. The results showed that the difference between the total pre and post assessment ratings means was significant. On average, the post-assessment ratings ($M = 3.45$, $SD = 1.01$) were higher than the pre-assessment ratings ($M = 2.98$, $SD = .91$), $t = -2.585$, $df = 15$, $p < 0.05$. However, the difference in the pre and post-assessment ratings was significant for only some teaching-related strategies: Differentiated Instruction: $t = -3.944$, $df = 14$, $p < 0.01$; Classroom Teaching, $t = -1.922$, $df = 13$, $p < 0.01$; and Common Core Standards, $t = -2.848$, $df = 12$, $p < 0.05$.

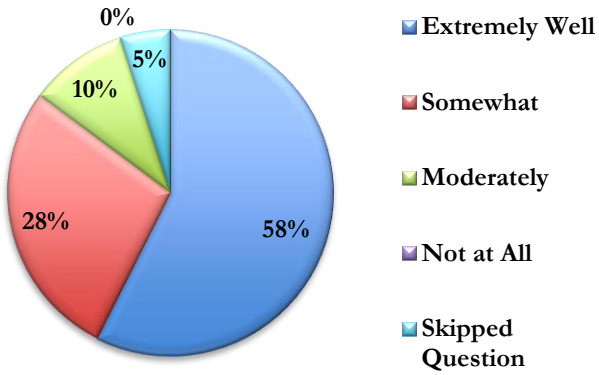
In addition, Figure 3 shows a summary of the Fellows' knowledge in various teaching areas prior to the Institute, and Figure 4 shows a summary of the Fellows' knowledge after the Institute.

Figure 3. Summary Ratings of Fellows' Perceptions of Teaching Prior to Summer Institute TXSU New Teachers

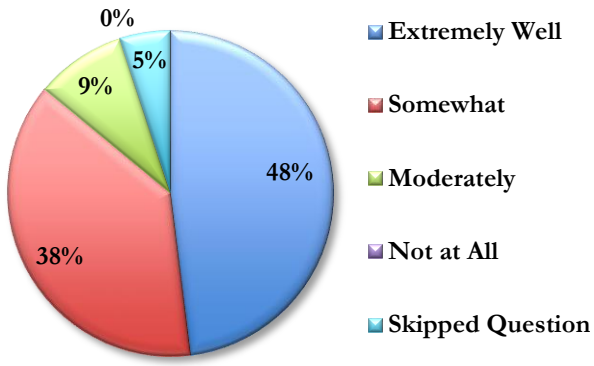
a. Classroom Management



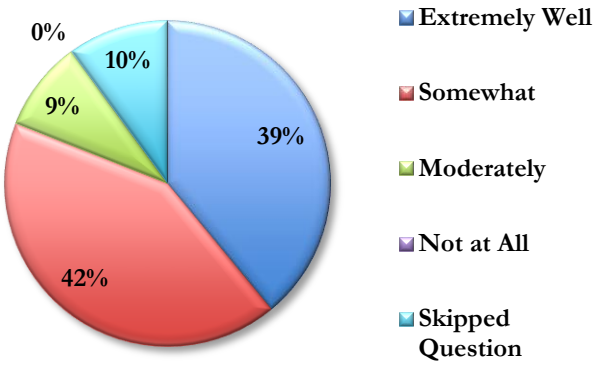
b. Knowledge of Classroom Standards



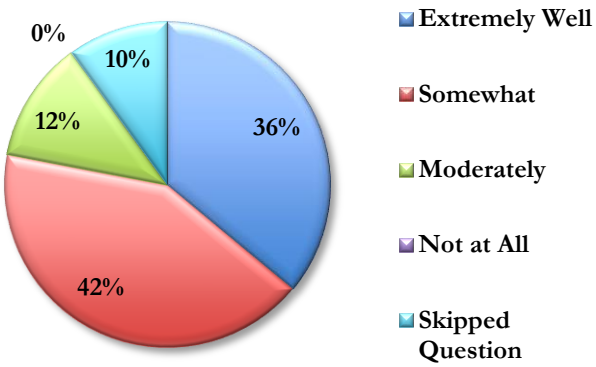
c. Knowledge of Differentiated Instruction



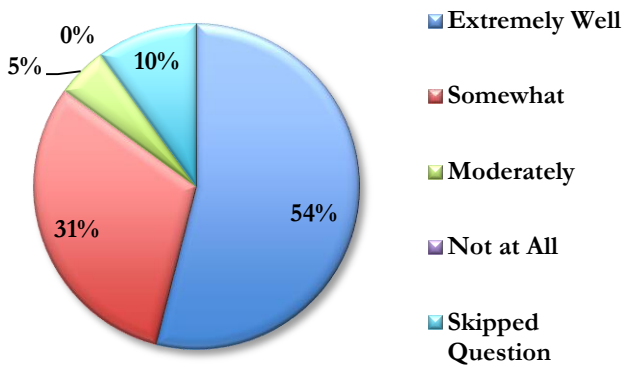
d. Knowledge of Lesson Objectives



e. Knowledge of Classroom Teaching



f. Knowledge of Technology



g. Knowledge of Common Core Standards

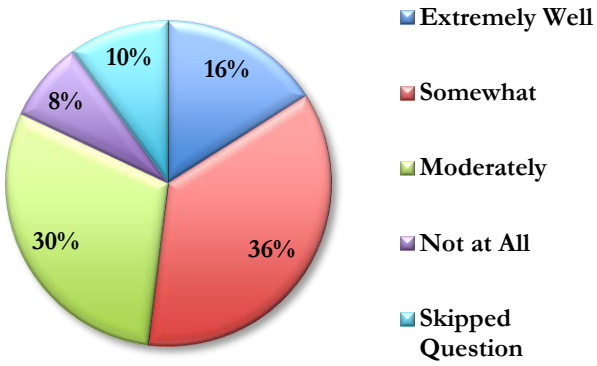
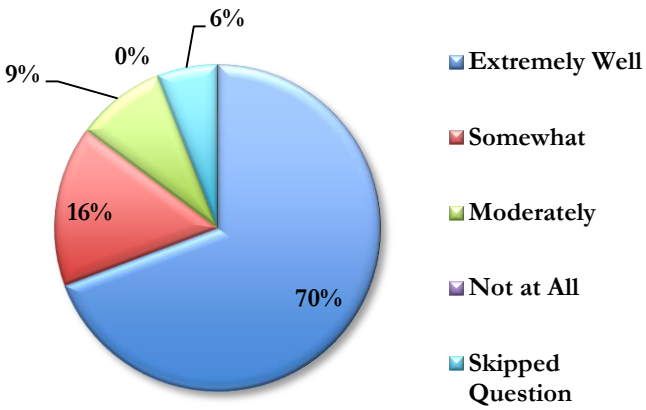
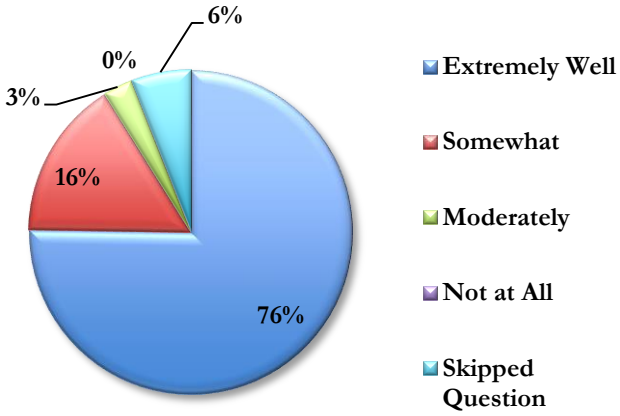


Figure 4. Summary Ratings of Fellows' Perceptions of Teaching after Summer Institute
TXSU New Teachers

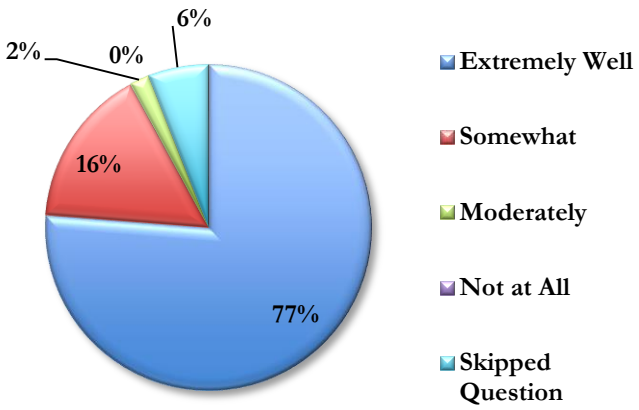
a. Classroom Management



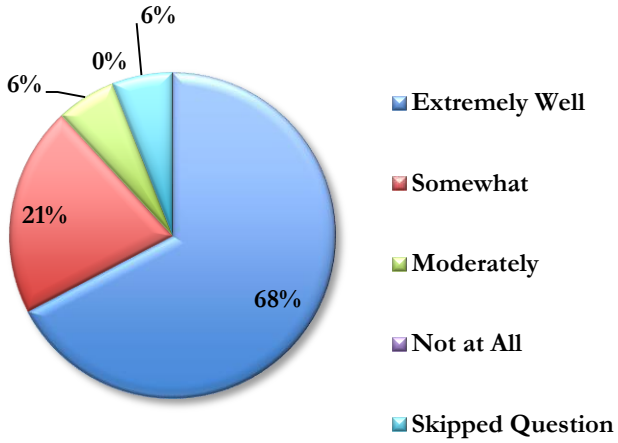
b. Knowledge of Classroom Standards



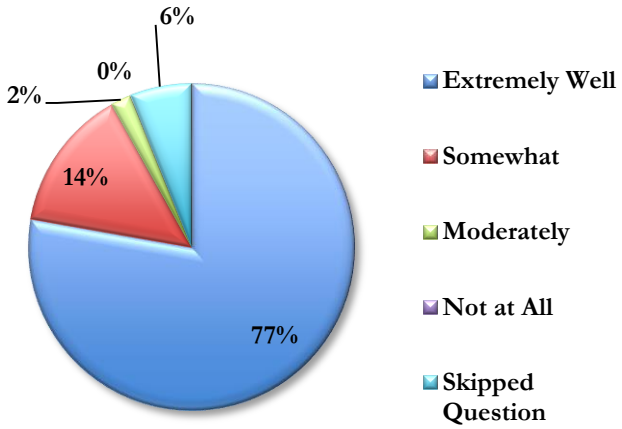
c. Knowledge of Differentiated Instruction



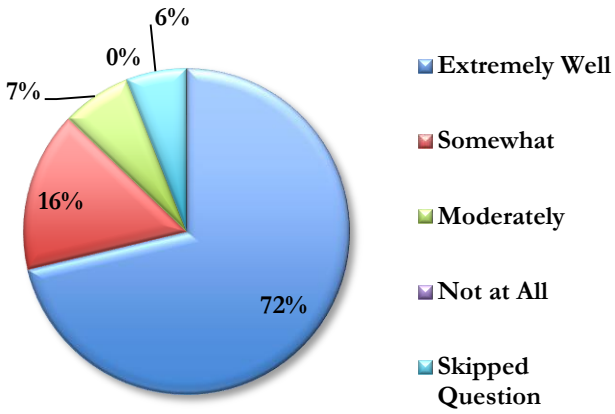
d. Knowledge of Lesson Objectives



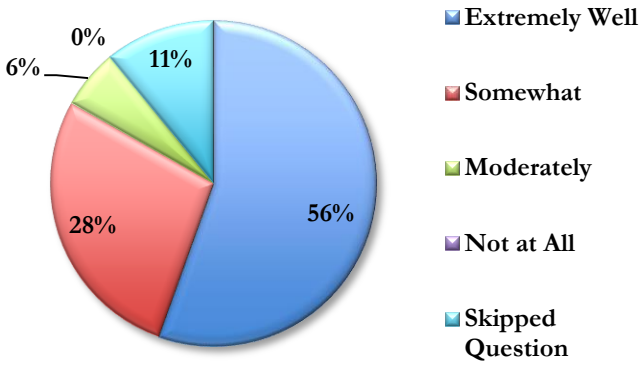
e. Knowledge of Classroom Teaching



f. Knowledge of Technology



g. Knowledge of Common Core Standards



g. Knowledge of Common Core Standards

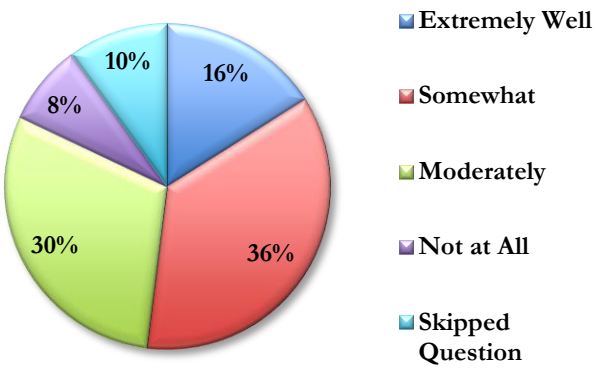
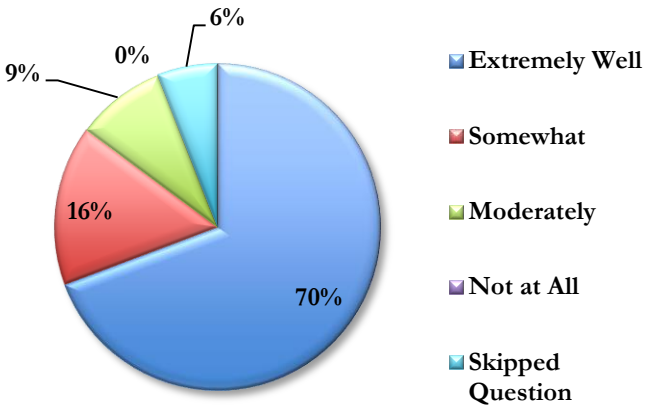
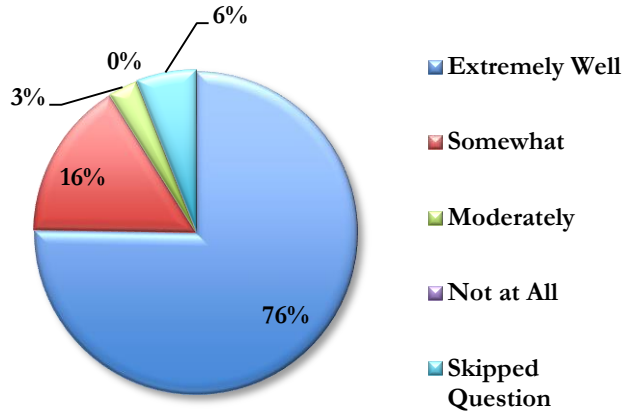


Figure 4. Summary Ratings of Fellows' Perceptions of Teaching after Summer Institute TXSU New Teachers

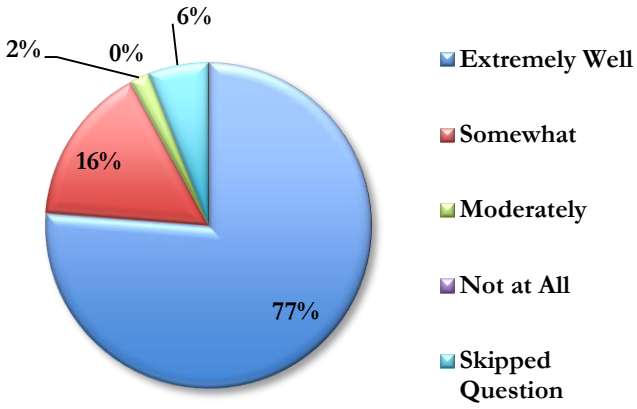
a. Classroom Management



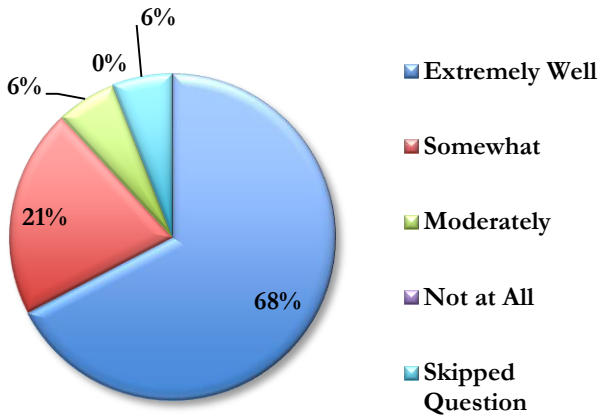
b. Knowledge of Classroom Standards



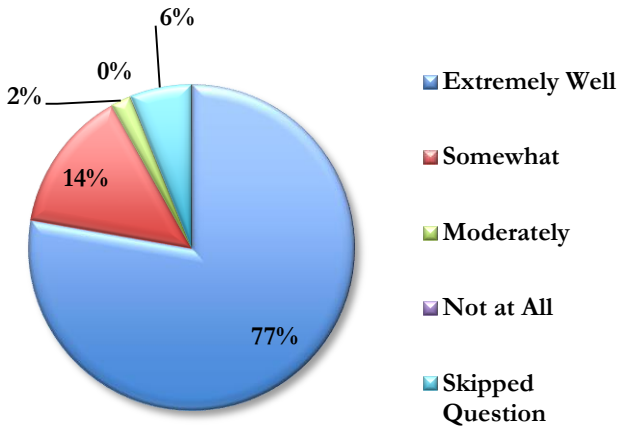
c. Knowledge of Differentiated Instruction



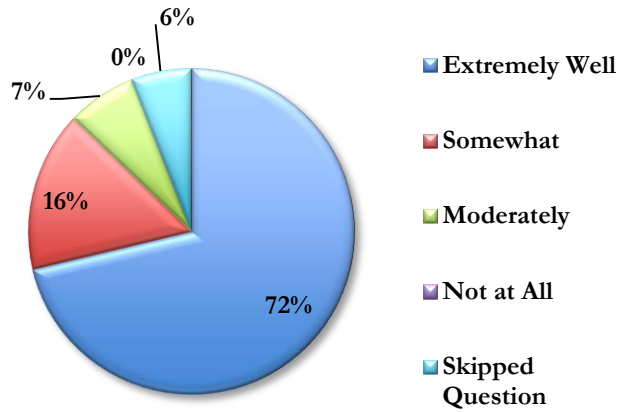
d. Knowledge of Lesson Objectives



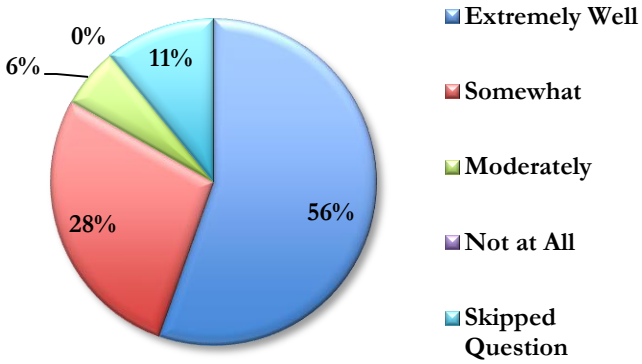
e. Knowledge of Classroom Teaching



f. Knowledge of Technology



g. Knowledge of Common Core Standards



II. Filling the STEM Pipeline

TMCF's STEM pipeline activities are designed to address the AFOSR's aim to support the preparation of students who graduate with STEM degrees. To this end, TMCF created the Payne Global Initiative, which has conduced the following:

1) Fact-finding missions to Asia and South Africa in 2009-2010
2) Fact-finding mission to Taiwan in March 2013
3) Partnership planning meetings with key leaders in higher education and government and industry in Taiwan in September 2013

These fact-finding missions, which constituted Phase I of this initiative, focused on the collection of intelligence from universities that demonstrated successful academic programs in the sciences.

In Phase II, TMCF consulted with a diverse group of educational leaders in science and technology, international educational advocates and the leadership of the Humpty Dumpty Institute (HDI), TMCF's partner in global affairs. In view of recommendations from HDI and others, the TMCF held a series of meetings with the Ambassador and senior staff of the Taipei Economic and Cultural Office (TECO), in New York and worked with HDI and TECO for several months in establishing relationships with key Taiwanese leaders in higher education, government and industry. As a result of these meetings, TMCF decided to conduct a fact-finding mission to Taiwan as part of Phase III.

Phase III

According to the Times (QS) Higher Education World University Ratings, eight Taiwanese campuses are among the top 500 universities in the world. There are 165 institutions of higher education in Taiwan and nearly 70 percent are classified as universities. Engineering degrees account for more than a quarter of all bachelor degrees awarded in Taiwan. Most notably, their universities have graduated several Nobel Laureates in Chemistry, Physics and other scientific and technological fields. Around 50 Taiwanese universities have joint dual-degree programs with foreign universities; in 2011, more than 50,000 foreign students studied in Taiwan and upward of 27,000 Taiwanese students attend U.S. campuses.[1]

The Taiwanese people are very well educated; literacy is about 96 percent, and their students consistently post high scores on international achievement tests. To a large extent, these achievements are the product of cultural and social values that hold education and science and technology in high esteem.

Taiwan is the world's 26th-largest economy--an economy primarily fueled by technological innovations. The most recent Global Competitiveness Index places Taiwan 12th in the world. Additionally, Taiwan is America's ninth-largest trading partner, with two-way trade exceeding $61 billion annually. The U.S. recently signed an agreement for cooperation with the American Institute in Taiwan and the Taipei Economic and Cultural Office to promote peaceful uses of

[1] www.timeshighereducation.co.uk/world-uni

nuclear energy.[2] The U.S. also supported Taiwan's membership in the International Civil Aviation Organization (ICAO).[3] Thus, increasingly, the U.S. and Taiwan share a wide range of economic and national-security interests that support TMCF's program goals.

Taiwan possesses a number of flagship universities in the sciences; they produce a significant number of advanced degrees in STEAM and have a long history of working in partnership with the U.S. government and American universities. Above all, the vitality of their professoriate, their world-rank research labs and centers and their growing prominence in science and technology were all very compelling. As an initial step, in March 2013, TMCF took a delegation of senior faculty in the sciences to Taiwan to collect intelligence through meetings with the leadership of the following:

- American Institute in Taiwan
- Fulbright Taiwan, Foundation for International Education Exchange
- Hsinchu Science Park
- Ministry of Education
- Ministry of Foreign Affairs

and the presidents and faculty at seven Taiwanese universities:

- National Central University
- National Cheng Kung University
- National Chung Hsing University
- National Pingtung University of Science & Technology
- National Taipei University of Technology
- National Taiwan University of Science & Technology
- National Tsing Hua University

Considering all the intelligence collected from both fact-finding missions and based on the outcomes of meetings with key government leaders, faculty and senior administrators in Taiwan, the TMCF decided to establish partnerships with three universities. The delegation conducted an inventory of resources, clarified roles and responsibilities and constructed a framework for long-term partnerships that could be launched with minimal staff. TMCF signed formal "agreements" with each of the universities and has established a "Partnership Coordinating Committee" that will have the primary responsibility of setting goals; developing plans for executing the partnerships and aligning policies and programs to carry out the partnerships. The Committee also will develop criteria for the selection of students and faculty and facilitate and monitor progress. Equally important, the Committee will be responsible for formulating a budget, outlining cost sharing, operational strategies and areas of specialization. The three partner universities are:

National Central University **(NCU)**, founded in 1915 and reestablished in 1962 in Taiwan, is located in Taoyuan County, Zhongli City. The University enrolls 11,800 students and employs

[2] www.whitehouse.gov/the-press-office/2013/12/20/presidential-determination-taiwan
[3] www.whitehouse.gov/the-press-office/2013/07/12/statement-president-hr-1151

a full-time faculty of more than 740 in seven colleges. It is a teaching university with a wide variety of world-famous research units. NCU is one of Taiwan's seven research universities.

The TMCF delegation met with several NCU officials, including: President Dr. Jin-Yang Jou; Associate Dean, Dr. Yin-yi Lin, Department of Communication Engineering, College of Electrical Engineering and Computer Science; Electrical Engineering Department Chair Dr. Hwann-Kaeo Chiou; Civil Engineering Department Chair, Dr. Hsieh-Lung Hsu; and Director of the Center for Space and Remote Sensing Research, Dr. Fuan Tsai.

NCU officials were quick to suggest that the University patterns itself after Purdue University, which has grown from a teaching university to a premier research institution. The reference to Purdue is further evidence of the University's intent to increasingly internationalize its programs and international initiatives.

NCU has seven colleges with a primary interest in engineering--College of Liberal Arts, College of Science, College of Engineering, College of Management, College of Electrical Engineering and Computer Science, College of Earth Sciences, and College of Hakka Studies (a particular culture). Nearly all of its undergraduate programs are taught in Chinese. Courses taught in English are generally confined to the graduate level. For students wishing to attend the fall semester, NCU recommends that they take a summer Mandarin course. NCU offers scholarships and subsidies geared toward foreign students to offset tuition and make enrollment at NCU financially attractive. The University offers student and faculty-exchange programs, internships and dual-degree programs.

NCU, as was the case with other Taiwanese campuses that the TMCF delegation visited--was enthusiastic about establishing international relationships. The University was particularly assertive in "pushing" its international master's-degree program in Applied Material Science.

One reason NCU is credited with so much success in graduating large numbers of students in the sciences is the University's longstanding policy of pairing incoming science majors with mentors to improve academic performance and success in upper-level courses. NCU claims that this practice has had a major impact on the academic achievement of students and the University's graduation rate. NCU offers the typical student and faculty exchange programs, distance learning, dual degree and collaborative faculty opportunities.

NCU researchers are exploring diverse fields of science and technology, but are focused on performing experiments with the ultimate goal of having their practical results and products patented.

National Taipei University of Technology (NTUT/Taipei Tech), founded in 1912, is one of the oldest technology institutions in Taiwan. It is located in the heart of Taipei City's Daan District. Taipei Tech enrolls about 12,000 students, including around 300 students from 35 countries. It is considered a world-green university (an environmentally sensitive campus), is one of the top two technical universities on the island and has a strong tradition of training leaders in engineering and entrepreneurship.

The TMCF delegation met with Dr. Sheng-Tung Huang, Dean of the Office of International Affairs and Dr. Michael Tanangkingsing, Chief of the International Cooperation Section.

The Times Higher Education World University Rankings places Taipei Tech at 100 in regional rankings for 2012-2013. The University offers 17 undergraduate degrees, 26 master's degrees and 16 doctoral programs with several graduate-degree programs taught in English. The University's graduate programs in Energy & Optoelectronic Materials, Civil & Environmental Engineering and Creative & Sustainable Architecture Studies have proved vital to sparking the Taiwanese economy. Additionally, several of the University's educational and research programs also have had a positive impact on Taiwan's economy, including: Biotechnology, Engineering, Automation Technology, Electrical Engineering and Computer Sciences. The University's emerging Biotechnology program is focused on driving innovation and commercialization in business and industry.

Taipei Tech appears to be aggressively courting foreign universities and has partnerships with more than 200 campuses, 30 of which are in the United States. Although Taiwan is a Chinese-speaking island, demographically it has a large population of young people who are fluent in English. It appears that in an attempt to attract English-speaking students--and cultivate international citizens--many of the universities, including Taipei Tech, offer a number of courses in English. Taipei Tech offers free Mandarin courses to foreign students and numerous opportunities for student and faculty exchanges, dual degrees and research partnerships.

National Tsing Hua University (NTHU) was founded in 1911 and reestablished at its current location in Taiwan in 1956. It is located in Hsinchu City, the Dong District of Taiwan and is considered one of the top Taiwanese universities. The 2013 Academic Ranking of World Universities places NTHU number three among institutions of higher learning in the People's Republic of China (PRC), Taiwan, Hong Kong and Macao, the four geographic regions that comprise Greater China.

NTHU's enrollment is approximately 12,000, almost equally divided between undergraduate and graduate students. NTHU has seven colleges in General Studies, Engineering, Electrical Engineering & Computer Science, Life Sciences, Nuclear Sciences, Humanities and Social Sciences and Technology Management. The University enrolls more than 600 international students and operates a Chinese Language Center that runs during the regular school year as well as in the summer. NTHU claims to provide the best Mandarin language/literacy instruction in Taiwan and boasts that students who study Mandarin at NTHU can become literate in only six-weeks of intensive language immersion. NTHU has 13 Academia Sinica Academicians (Central Research Academy) as faculty, 16 professors who have earned various national awards and 50,000 alumni, including Nobel Laureate Yuan Tseh Lee, who received the 1986 Nobel Prize in Chemistry.

In 2012, the Times Higher Education ranked NTHU 226-250 in the world; it has the highest level of per-student funding from the MOE and substantial research support in the areas of Nuclear Science & Technology, Nanotechnology, Materials Science and Microsystems. In 2011, the University received 112 patents and implemented 88 technology-transfer projects.

Meetings were held with the Vice President for Global Affairs, Dr. Wei-Chung Wang and Chair of the Engineering and System Science Department, Dr. Fan-Gang Tseng.

Selection of the three partnership universities was reinforced by the leadership of the Humpty Dumpty Institute (HDI), Taipei Economic and Culture Office (TECO) and key U.S. leaders involved in governmental affairs and higher education in Taiwan.

At the same time, given the distinction of the remaining universities in the sciences, the delegates urged that the TMCF encourage cooperation to include all seven universities in Taiwan with a select group of *public* HBCUs to explore opportunities for collaborating around the central issues of:

- Pedagogical policies and practices that drive success in the retention and graduation of students in the sciences
- Integration and application of knowledge in the sciences
- Imaginative and creative insights on the most effective dimensions of scholarship and research in the sciences
- Emerging trends and breakthroughs in the world of science and technology
- Professional development of faculty in the sciences
- Research initiatives across scientific disciplines

These three universities are highly resourced, are conducting cutting-edge research and are accomplished in building fully integrated science and technology programs at the undergraduate level through the Ph.D. level and beyond. Although the remaining four universities were highly competitive, time and resources prohibited TMCF from developing formal partnerships. However, TMCF will explore relationships around common areas of interest and specialization with a select group of *public* HBCUs.

The three partnerships are designed to:

- Identify and replicate academic, scholarly, and management of best-practices pinpointed during the various fact-finding missions
- Drive change by serving as a national advocate for STEAM innovations with policymakers in the highest councils of government and business
- More fully integrate and align STEAM programs with the mission of the TMCF-member campuses
- Invest in strengthening infrastructure and capacity at the TMCF member- universities to enhance teaching and learning in STEAM fields of study
- Bolster global partnerships, bilateral exchange programs and joint research projects aimed at enhancing STEAM education and the production of human capital--talented graduates--in various scientific disciplines

The three TMCF member-schools that were selected to partner with the three Taiwanese campuses were chosen given their distinctions in science and technology and their exemplary leadership in international affairs. These schools are:

Alabama State University (ASU), founded in 1867, is a historically Black university and is located in Montgomery, AL. While the University has distinguished itself as a teaching institution, it now is focused on building a vibrant research program in the sciences. Since 2005, ASU has been awarded more than $7.5 million in National Science Foundation grants and is breaking new ground in Nanotechnology, alternative energy, disease prevention and related fields. Research at ASU's Center in Nano Biotechnology is driving the University's scientific reputation and is attracting exceptional students and scholars to the campus from around the world. The University's East Asian Institute for Business Research & Culture is conducting studies on the global economy and has established an enviable reputation for its work in Medicine and Genetics. Alabama State's undergraduate and advanced-degree programs in Forensic Sciences and Micro/Marine Biology have been highly successful in attracting some of the best and brightest U.S. and international students and faculty.

In 2011, ASU awarded its first doctorates in Microbiology to three students from India, Turkey and Sudan. The University offers a degree in Electrical, Civil or Aerospace Engineering with a dual-degree in Mathematics and Engineering from ASU and Auburn University or the University of Alabama.

ASU annually enrolls more than 123 international students from over 30 countries and annually awards over 50 degrees to foreign students in STEAM. It has established partnerships with more than 30 universities around the world and is playing an increasingly major role in Computational and Nanobiotechnology.

Alcorn State University (ASU), founded in 1871, is the second oldest Black land-grant university and is located in Alcorn State, Mississippi. For two consecutive years, U.S. News & World Report has ranked ASU among the top 30 HBCUs based on its strong academic reputation. Alcorn has seven colleges, offering undergraduate and graduate programs in Agriculture, Robotic Engineering and Industrial and Information Technology as well as other STEAM disciplines. In addition to SACS (Southern Association of Colleges and Schools) endorsement, the University holds accreditation in numerous professional disciplinary accrediting bodies, including the National Association of Industrial Technology. Alcorn recently established several new academic and research facilities in the sciences, and most impressively in the area of Ecology and Biotechnology. Alcorn also is investing heavily in bioenergy research. The Department of Advanced Technologies offers a bachelor's of science degree in Advanced Technologies with programs in Applied Science, Computer Networking and Information Technology and Robotics and Automation Technology. Alcorn has established a major research radiation monitoring/measurement laboratory, which is an addition to the Center for Radiation Monitoring and Medical Therapies and is a unit of its Systems Research Institute. The School of Agriculture and Applied Sciences (including Agriculture and Advanced Technologies), and the School of Arts and Sciences (Which includes other STEAM disciplines) graduate more than 250 students annually.

The University annually enrolls about 114 students from 10 countries and each year awards more than 25 degrees to international students. Alcorn has established partnerships with universities around the world and is playing an increasingly major role in agricultural sciences and biotechnology.

STEAM related departments at the University place heavy emphasis on providing students with meaningful domestic and international experiential learning opportunities. For example, the Department of Biology has sponsored for more than 10 years (annually) a 10-week summer intensive research internship for STEAM students. The program has successfully trained more 100 undergraduate and graduate students. Furthermore, a large percentage of these students have published research results in peer-reviewed professional journals as co-authors along with their faculty advisors at Alcorn State University and their professional mentors at partnering universities in India.

North Carolina Agricultural and Technical State University (NCA&T), founded in 1890, is a public, doctoral/research, 1890 land-grant University committed to exemplary teaching and learning, scholarly and creative research, and effective engagement and public service. The University offers degrees at the baccalaureate, master's and doctoral levels and has a commitment to excellence in a comprehensive range of academic disciplines. NCA&T's unique legacy and educational philosophy provide students with a broad range of experiences that foster transformation and leadership for a dynamic and global society. The University is located in Greensboro, North Carolina and is a part of the sixteen campus University of North Carolina system.

Over 175 undergraduate, 45 master's and 11 doctoral majors through the nine schools and colleges including agriculture and environmental sciences, arts and sciences, business and economics, education, engineering, nanoscience and nanoengineering, nursing and technology. NCA&T's Joint School of Nanoscience and Nanoengineering (JSNN) is an academic collaboration between NCA&T and the University of North Carolina at Greensboro. Located on the South Campus of Gateway University Research Park, the joint school builds on the strengths of the universities to offer innovative, cross-disciplinary masters and doctorates in the emerging areas of Nanoscience and Nanoengineering. JSNN offers numerous opportunities for collaboration with industrial and university partners, particularly in Nanobiology, Nanometrology, Nanomaterials, Nanocomposite, Nanobioelectronics, Nanoenergy and Computational Nanotechnology. JSNN is housed in a $56.3 million, 105,000-square foot state-of-the-art science and research building and it features nanoelectronics and nanobio clean rooms, Nanoengineering and Nanoscience laboratories and extensive materials-analysis facilities.

Among JSNN's highly sophisticated array of scientific equipment is a suite of Carl Zeiss microscopes, including the only Orion Helium Ion microscope in the Southeastern U.S. It also has the capability to do three-dimensional imaging for modeling of Nanotechnology problems. With 13 departments and programs in eight buildings, the College of Arts and Sciences is the largest academic unit at N.C. A&T, and is at the heart of any well-rounded course of study. Proud of its reputation as the largest producer of African American engineers, the College of Engineering is home of the prestigious National Science Foundation's Engineering Research Center for Revolutionizing Metallic Biomaterials which conducts collaborative research in the areas of biomedical engineering and nano-bio applications in partnership with an international collaboration of universities. The AACSB accredited School of Business and Economics occupies a modern facility including a Financial Trading Room and has excellent partnerships with major corporations. The School of Agriculture has a rich history of innovation and application of cutting-edge technology as well as award-winning Cooperative Extension and

Agricultural Research programs. The School of Technology offers programs in Applied Engineering Technology, Construction Management, Electronics Technology, Environmental Health and Safety, Geomatics, Graphic Communication Systems, and Motorsports Technology.

North Carolina A&T enrolls over 10,000 students including about 400 international students and annually awards more than 100 degrees to foreign students. NCA&T has crafted partnerships with more than 15 universities around the world and is noted for its role in engineering, technology, computer science, nanotechnology, agricultural and environmental sciences.

Planning & Developing

The TMCF proposes establishment of a "Partnership Coordinating Committee" (PCC) that will include representatives from each university representative involved in this new partnership. Initially, the PCC will focus on four priorities:

- Bilateral student exchanges,
- Bilateral faculty exchanges,
- Jointly sponsored research and
- Capacity building in STEAM

Bilateral student exchanges will comprise:

- One semester or year-long embedded Chinese language and culture course
- A bilateral student exchange program for one semester

Among the key features of the bilateral faculty-exchange program are:

- Bilateral faculty-exchange program ranging from two weeks to a semester
- Co-teaching program using digital technology and
- Seminars, workshops and conferences cosponsored by U.S. and Chinese campus partners

The bilateral faculty exchanges will require:

- An inventory and creation of a database of faculty expertise in STEAM at each participating university
- Creation of a communication platform to share information and encourage bilateral discussions among scientists for the purpose of facilitating collaboration
- Identification of funding sources and generation of support for the development and execution of joint-research projects
- Review of institutional policies and practices for faculty/scientists' sabbaticals and
- Institutional clearances to implement the faculty-exchange program

Jointly sponsored research efforts may include:

- Eight-to-10-week summer-research internships at laboratories located at Taiwanese universities
- Eight-to-10-week Chinese-language training either as a stand-alone activity or in conjunction with summer-research internships

These public HBCU-Taiwanese-campus activities will require capacity building in STEAM to include:

- Sharing curricula and content, plus content from online courses
- Identifying models and policies and best practices for academic success in the sciences
- Creating a common set of rigorous academic standards, benchmarked to Taiwanese universities
- Undertaking an inventory of human and physical assets in the sciences
- Developing a research and development portfolio in the sciences

In the first year of the public HBCU-Taiwanese-university partnership, each public HBCU will nominate six STEAM students for a semester-long study-abroad experience and two STEAM students for a 10-week summer-research internship. From the three public HBCUs involved in the partnership, the PCC will select 18 students for the study-abroad program and six students for the summer research-internship program. Similarly, each Taiwanese campus will be asked to host six students for the study-abroad experience and two students for the 10-week summer research internship.

As this initiative evolves, the TMCF will work in tandem with the PCC to tailor various relationships around four key areas of mutual interest. The TMCF will concentrate on creating an opportunity-driven environment designed to multiply new ideas and innovations as well as to sustain and strengthen cooperation. Additionally, the TMCF will formalize a process to institutionalize the "Taiwan Academy" at a select group of TMCF-member universities. The Taiwan Academy is a program of TECO created to showcase Taiwan's many cultures, to promote an interest in Mandarin Chinese and to elevate Taiwan's presence on the international stage. The Academy will be promoted through digital technology, through a Virtual Taiwan Academy and through real-world locations as a platform for educational and cultural exchanges. Formalize a process to facilitate virtual (real-time) exchanges between TMCF institutions and Taiwanese universities.

Partnerships Overview

National Central University

Activities (Proposed)

- Summer internships for students attending TMCF-member campuses and research sabbaticals for faculty employed by TMCF-member institutions,

- Summer-language programs for TMCF students prior to participating in research internships at National Tsing Hua University and National Taipei University of Technology,
- Teaching collaborations and curricula development,
- Faculty and student exchanges and
- Semester-long study-abroad experiences for undergraduate and graduate students.

Areas of Study

- Chemical and Materials Engineering
- Electrical Engineering and Computer Sciences
- Remote Sensing
- Molecular Science Technology (Biotechnology)
- Environmental Engineering
- Bioinformatics
- Physics with an emphasis on Optics and Photonics

Calendar

Fall semester: September-January

Spring semester: February-June Summer: July-August

Academic Year--Cost of Education

	Undergraduate (U.S.$)	Graduate (U.S.$)
Tuition/Fees	$2,500	$2,500
Health Insurance	$316	$316
Total Expense	$2,816	$2,816

Note: On-campus housing is available for $75-$100 per month or off-campus at

$300-$350 per month. Other living expenses (meals, transportation, etc.) are estimated to cost in the range of $250-$300 a month.

National Taipei University of Technology

Activities (Proposed)

- Teaching collaborations and curricula development
- Faculty and student exchanges
- Semester-long study aboard experiences
- Jointly sponsored research projects,
- Engage students and faculty in internships and research

Areas of Study

- Biotechnology
- Chemistry
- Civil, Mechanical and Electrical Engineering
- Computer Sciences
- Industrial Technology
- Chemical Sciences
- Innovation and commercialization of technology

Calendar

Fall semester: September-January

Spring semester: February-June

Summer: July-August

Deadline for student-exchange applications: February 18-April 20 for

Fall semester; August 1-October 15 for Spring semester

Academic Year--Cost of Education

	Undergraduate (U.S.$)	Graduate (U.S.$)
Tuition/Fees	$3,580	$4,170
Health Insurance	$316	$316
Total Expense	$3,896	$4,486

Note: On-campus housing is available for $110-$210 per month or off-campus accommodations are available for $350-$500 monthly. Other living expenses (meals, transportation, etc.) may cost in the range of $250-$300 a month.

National Tsing Hua University

Activities

- Study-abroad experiences for students
- Teleconferences, seminars and workshops
- Dual-degree programs
- Faculty and student-exchange programs
- Chinese language programs for students

- Summer research internships
- Summer research internships at NTHU and affiliated research and development centers, parks and businesses
- Internships in the Center for Innovation Incubation
- Bilateral research and teaching sabbaticals for faculty in Nuclear Science

Areas of Study

- Technology
- Nanotechnology
- Materials Science and Microsystems
- Electrical Engineering

Computer Sciences and Chemistry

Calendar

Deadline for student-exchange applications: January 1-March 15 for Fall semester; September 1-November 1 for Spring semester

Academic Year--Cost of Education

	Undergraduate (U.S.$)	Graduate (U.S.$)
Tuition/Fees	$3,200	$2,200
Health Insurance	$316	$316
Total Expense	$3,516	$2,516

Note: On-campus housing is available for $65-$180 per month or off-campus for $300-

$350 monthly. Other living expenses (meals, transportation, etc.) may cost $500.

HBCUs will initially engage in these activities in several ways:

Alabama State University, Alcorn State University and North Carolina A&T State University will be the first group of public HBCUs to participate in the partnership and
Lessons learned from the initial implementation phase will be used to expand the group of participating universities in a greater number of activities.

Organization. The Provost at each public HBCU will designate delegates to serve on the "Partnership Coordinating Committee" (PCC), which will have the responsibility for developing and managing collaborations with the Taiwanese campuses under the aegis of the TMCF to:

- Customize a framework for executing individual partnerships
- Develop policies and procedures to govern the partnerships
- Determine activities within the four priority areas
- Develop criteria for the selection of students and faculty
- Develop a standard application and guidelines for students and faculty
- Evaluate and select students and faculty

Study-Abroad Structure

Study-abroad students will spend four to six weeks in a Chinese language and cultural immersion program in Taiwan during July and August, prior to starting their semester. In the fall semester, students will take 15 credit hours at a Taiwanese university:

- Six-credit hours in a STEAM major at a host university with the expectation that credits will be transferred back to the student's program of study at his/her home institution
- Three-credit hours of Chinese-language instruction at a host university
- Three-credit hours of Chinese history, culture, politics and economics at a host university

- Three-credit hours of independent research under the guidance of a faculty member and/or graduate student at a host university

Research Internship Structure

The research internship will consist of a 10-week campus-based experience in a laboratory setting under the supervision of faculty or a graduate student. In addition to the internship, students will be required to take a Chinese-language course at a host university. At the conclusion of the internship, students will submit a report to his/her institutional representative on the "Partnership Coordinating Committee" (PCC), which will include:

- A brief description of the research problem examined
- An explanation of the approach taken
- An account of the results obtained

The report also will include an evaluation of their Chinese-language skills. The deadline for these reports will be within 30 days when students return from Taiwan.

Student & Faculty Selection Process

The PCC will disseminate notices to all qualified students and request completed applications by the stated deadline. Applications should include copies of students' transcripts, two letters of recommendation, and essays addressing students' academic and career interests as well as discussing the value of a study-abroad experience. Following initial screening by a campus-based selection committee organized by the PCC member, the committee will review applications and submit recommendations to the TMCF for consideration by the PCC.

The PCC will disseminate notices to STEAM faculty members who may be interested in joining the first group of students traveling to Taiwan for study. Faculty should demonstrate interest in co-teaching opportunities as well as sponsoring seminars and workshops in addition to conducting research in cooperation with faculty at the host university. The PCC will outline criteria for selection of three faculty members for the initial year and will carry out the same selection process and timeline proposed for the students. It is anticipated that faculty will be required to prepare a letter of interest, outlining the nature and scope of their academic work in STEAM and the extent to which it matches the overarching mission of the partnership. Of course, this recommendation must be approved by the appropriate administrative unit or units at the participating university.

Timeline

October 30	Applications due
November 15	Initial screening and final selection
November 30	Selection Committee's recommendation is submitted to the TMCF
December 2	TMCF reviews, confirms acceptance of recommendation and convenes PCC for final selection
December 6	PCC notifies students
December 10	Students accepts offer in writing
December 15	TMCF announces the final list of students from each campus
December 16	TMCF finalizes housing assignments in Taiwan

December 16	TMCF notifies Taiwanese universities
December 15-January 15	Students apply for passports (if needed)
December 15-January 15	Students apply for emergency medical insurance
January-February	Students prepare for travel to Taiwan
March	Students make airline and housing arrangements

Learning Objectives

The new partnerships will have several learning objectives:

- To understand the breadth and scope of technical skills in the academic areas assigned
- To experience and appreciate learning and living in the Taiwanese culture
- To participate in language and cultural immersion programs
- To use Mandarin to function optimally in Taiwan
- To forge new relationships and to broaden academic and research opportunities, and
- To adapt existing and newly gained knowledge to spur further success in STEAM fields of study

Inventory of Resources

TMCF will construct an online platform listing STEAM courses, research laboratories and centers as well as the teaching and research interests of faculty at participating universities. The TMCF will create a communications network to ease communication between deans, faculty and students in STEAM.

Principles of Working Together

The lead institutions will work through TMCF's PCC to launch the initial program in Taiwan. Within three-to-five years, each participating institution will be more independently involved and will only coordinate the funding and reporting aspects of the program through TMCF. After data are generated, determining the success of the initial efforts, it is hoped that models developed by the lead institutions will then be replicated by other TMCF member-schools.

Anticipated Impact

Partnerships among the Taiwanese universities and TMCF member-schools are expected to yield positive STEAM relationships by exposing students to methods of teaching, learning, research and work-product production, i.e., the process of taking innovations and discoveries from theory to practice. Students will gain a better understanding of cultural differences in the application of knowledge and help students and faculty at host institutions learn more about American methods and practices as well as American culture.

As the number of TMCF students increase in Taiwan, the expectation is that Taiwanese students and faculty will enthusiastically seek opportunities to study, teach and conduct research at TMCF member-schools.

Proposed Budget & Funding Sources

During the program's initial stages--specifically its first three to five years--it is anticipated that the TMCF will cover the costs associated with student and faculty participation. These costs include: airfare, housing, tuition reimbursement and stipends. Exact costs will be determined based on acceptable group rates for travel, the availability of campus-based or off-campus housing in Taiwan and the cost of tuition at the member-university. TMCF, in conjunction with the PCC, will secure funding and serve as a clearinghouse for students and faculty recommended for participation in the program.

The average cost for faculty-led study-abroad programs range from $5,000 to $10,000 (USD) for a semester.

Performance & Progress Measurements

Prior to being selected to participate in the program, students will be screened by their home institutions and then recommended to TMCF's PCC for consideration. The PCC member at the host university will develop performance-scoring sheets to collect data on student accomplishments. The host institution will provide grades to the students' home institutions for courses taken for credit as well as progress updates on any research conducted during the duration of the study-abroad experience.

Research conducted by students and faculty will be reviewed on the GLOSSARI project that contains a detailed assessment and evaluation of study-abroad programs of the University System of Georgia. The study revealed that graduation and academic success rates for students who participated in study-abroad programs were higher than for other students. TMCF will conduct research with PCC assistance to demonstrate the effectiveness of all aspects of the partnerships and particularly the impact of study abroad on academic success and workforce placement following graduation in STEAM fields.

CAPACITY BUILDING

I. Increasing Retention and Graduation

TMCF's retention and graduation activities, which include the Consortium for Undergraduate STEM Success (CUSTEMS), are designed to address the AFOSR's aim to support the preparation of students who will be equipped for STEM careers in government and industry.

At TMCF's annual Consortium for Undergraduate STEM Success (CUSTEMS) conference, DOD AFOSR agencies have the opportunity to provide guidance to faculty on the specific skills necessary for work related to DOD AFOSR's mission critical programs. Armed with this knowledge, faculty can more closely align their curricula with the elements necessary to prepare students to compete successfully for DOD AFOSR and other related highly competitive settings.

TMCF's thirteenth annual Member Universities Professional Institute (MUPI): *Improving Retention, Increasing Graduation and Advancing Careers in STEAM*), occurred March 24 –March 27 in New Orleans, involving over 150 participants. MUPI is a capacity-building conference that

promotes best practice sharing and collaboration among TMCF's member-school network.

By enhancing the skills and knowledge of senior staff, the annual conference increases their expertise across a range of areas including student retention and graduation. Guest speakers were pioneers in the advancement of science, research and higher education such as Joan Higginbotham, retired NASA Astronaut and Roderick Pettigrew, Ph.D. MD, Chief Officer for Scientific Workforce Diversity at the National Institutes of Health. Panel discussion and roundtable topics included:

- Using Writing in the Sciences
- Improving Undergraduate Life Sciences
- Retention Strategies
- Closing Gaps in College Preparation
- Expanding Research Grant Opportunities

The institute agenda is located below.

Sunday, March 24th

6:30 pm – 8:00 pm Opening Reception

Monday, March 25

8:30 am – 10:00 am Morning Plenary

WHAT'S NEXT: STEAM CAREER AND GRADUATE PROSPECTS FOR STUDENTS

Kenneth Johnson
Director of Civil Rights, Diversity and Inclusion
U.S. Department of Agriculture

Pamela Hardy (tentative)
Senior Manager, Diversity & Inclusion
Booz Allen Hamilton

10:15 am – 11:30 am Concurrent Sessions

A Comprehensive Approach to Pre-Collegiate Readiness in Mathematics & Literacy

In 2012, Polite Stewart became one of the youngest graduates in the history of Southern University, receiving a B.S. in Physics at the age of 18. Foundational to Polite's achievement was his matriculation through Southern University's Timbuktu Academy, a pre-collegiate program that promotes literacy and mathematics readiness for students entering the university. Given the shortfalls of the precollege preparation of minority students in most states, Timbuktu Academy provides a model framework for (a) increasing the pool of minority college enrollees; and (b) for providing these enrollees with the essential mathematics and English skills needed for success in college. Learn how the Timbuktu Academy at Southern University uses a supportive, stimulating, and challenging environment to ensure

that students not only graduate from college, but that they are ready to tackle advanced STEM research in graduate programs.

Presenters:
Polite Stewart – 2012 Physics Graduate, Southern University (SU)
Dr. Diola Bagayoko, Director, Timbuktu Academy, SU
Dr. Ella Kelly – Associate Vice Chancellor for Academic Affairs Southern University, SU
Dr. Stephen McGuire – Professor of Physics, Southern University, SU

Exploring Student Retention & Migration Across STEM Fields: A Broad Research Methodology

The reasons why students *drop out* of STEM fields continue to be a topic of extensive study. Resisting this narrow approach, the Consortium for Undergraduate STEM Success (CUSTEMS), a TMCF grant initiative in partnership with Swarthmore College and supported by the Sloan Foundation, examines not only why students leave STEM disciplines, but also why certain students move *into* STEM fields and persist to graduation. In this session, CUSTEMS researchers will share their preliminary findings from data collected from TMCF member-schools and majority-serving institutions, and engage the audience in idea sharing based on the data presented.

Presenters:
Dr. Nana Lowell – Director, Office of Educational Assessment, University of Washington
Dr. Lynn Molter – Chair, Department of Engineering, Swarthmore College
Dr. Teresa Merriweather-Orok – CUSTEMS Research Consultant, TMCF

Recent Growth in Agricultural Programs at Tennessee State University: A Case Study

Agricultural programs at Tennessee State University have experienced tremendous growth. In the last four years, student enrollment has doubled. In addition, externally funded research has tripled to $55 million, helping to add more than 25 new Ph.D. faculty; triple expansion of outreach to 32 counties; and multiply graduate student enrollment at the M.S. level from 9 to 80 and Ph.D. level from 3 to 14. In this session, the methods used to achieve these results, including the recruitment and retention of students will be shared with colleagues interested in expanding the impact of their agriculture programs.

Presenters:
Dr. Chandra Reddy – Dean and Director of Research and Extension, College of Agriculture, Human and Natural Sciences, Tennessee State University (TSU)
Dr. Sandria Goodwin – Professor and Director, Didactic Program in Nutrition and Dietetics
Department of Family & Consumer Sciences
William Hayslett – Academic Coordinator, TSU
Dr. Sam Nahashon – Graduate Coordinator, TSU
Dr. Surendra Singh – Department Chair, Agricultural and Environmental Sciences, TSU

PULSE: Catalyzing Vision & Change for Improving Undergraduate Life Science Education

The 2011 report, "Vision and Change in Undergraduate Biology Education: A Call to Action" (V&C), recognized that a 21st century education requires changes to how the life sciences are taught, how academic departments support faculty, and how curricular decisions are made. The Partnership for Undergraduate Life Science Education (PULSE; www.pulsecommunity.org) is a collaborative effort

funded by NSF, NIH, and HHMI to foster changes recommended in V&C by supporting 40 Leadership Fellows in developing strategies to catalyze implementation of the recommendations at the department level and above at all types of post-secondary educational institutions. The Fellows have identified opportunities for and barriers to improving undergraduate life sciences education. Attend this session to learn and provide feedback on PULSE recommendations for instituting changes in life science education.

Presenters:
Dr. Sandra Romano – Interim Dean, College of Science & Mathematics, University of the Virgin Islands; PULSE Fellow
Dr. Mary A. Smith, Associate Professor and Chairperson, Department of Biology, North Carolina A&T University; PULSE Fellow

Closing the Gaps in College Preparation: A Secondary Education Perspective

To prepare students for success in college, there is general agreement that strengthening Science, Technology, Engineering, Agriculture and Mathematics (STEAM) teaching and learning is key to the United States' global competitiveness. While the number of STEAM jobs is increasing, the number of college graduates with STEM degrees has declined, especially among minorities. The lack of adequate STEAM readiness among high school graduates is one cause. In this session, participants will learn effective strategies and models for students to transition from the K-12 setting to higher education with the key skills, habits and knowledge to be successful in STEAM courses.

Presenter:
LaTonya Waller
2011 Teacher of the Year, State of Virginia

EXPANDING OPPORTUNITIES: ADVANCING HBCU STE*A*M RESEARCH

12:00 noon – 1:30 pm Afternoon Plenary

Roderic Pettigrew, Ph.D., M.D.
Chief Officer for Scientific Workforce Diversity
National Institutes of Health

1:45 – 3:00 Concurrent Sessions

A Systematic Approach to Using Consortium for Undergraduate STEM Success (CUSTEMS) Data

In 2011, TMCF was awarded a multi-year grant to examine the factors related to the retention and migration of students in and out of STEM disciplines. Funded by the Sloan Foundation in partnership with Swarthmore College and the University of Washington, this comprehensive research project examines data from both HBCUs and majority serving institutions. In its second year, data from the project are being used in significant ways. This workshop will explore the systematic approach the University of Maryland Eastern Shore has used to develop a strategic plan, implementation process, collaboration, and leadership protocols based on the CUSTEMS data. Special emphasis will be given to using data from CUSTEMS in the context of other related data, trends, and best practices for

creating a systematic approach for STEAM preparation. The session is designed to facilitate sharing challenges, solutions, ideas, and best practices.

Presenter:
Dr. Jichul Kim – Planning Analyst, Office of Institutional Research, Planning & Assessment
University of Maryland Eastern Shore

Crashing the Gates: A Look at the Redesign of Gateway Courses in Chemistry

General Chemistry plays a critical role in many science and technology programs. Currently however, there are a high course failure and withdrawal rates in the two-semester sequence of general chemistry, which makes it difficult for students to progress through their programs in a timely manner. This presentation will discuss the redesign of general chemistry II in which lectures are deemphasized; laboratories are closely aligned to classroom material; online tools are used to make student homework more effective; and ancillary instructors work with students outside of class time to provide supplemental instruction.

Presenter:
Dr. Abdul Mohammed – Professor of Chemistry
North Carolina Central University

Using Writing in the Sciences to Establish Quality STEM Participation

Studies have shown that writing, reading, and hands-on experiences, e.g., written laboratory reports, lead to greater critical thinking, thoughtful analyses of ideas, and better concept development. A literature review on writing research led Winston-Salem State University to establish four writing goals to enhance STEM students' writing skills, positively affect their writing behavior, and impact their efficacy beliefs. These goals include STEM students' ability to (1) demonstrate competence in written communication, using appropriate language, conventions, organization, supporting evidence, and content appropriate to the purpose and audience; (2) know and use the writing process to produce scientific papers, drawing upon available resources (3) use the criteria for judging effective writing, and (4) confidently write and provide useful feedback to peers. In this session learn how Winston-Salem State University has used this model, analyzed data related to program implementation, and developed subsequent modifications based on their findings.

Presenter:
Dr. Jill Keith Harp, Professor and Chair, Department of Life Sciences
Winston-Salem State University

Prep U Adaptive Quizzing Software: An Institution-Wide Retention Strategy for Nursing Students

PrepU is an adaptive computer software program that has been effective in preparing and retaining students in the College of Nursing at Prairie View A&M University located in the Texas Medical Center. After positive reception by both faculty and students and improved learning outcomes, PrepU has been expanded from Adult Health and Medical
Surgical Nursing courses to all semester levels in the generic program (Nursing Fundamentals, Health Assessment, and Family Health). Learn how the current program implementation, including recent

pilots in the upper division is resulting in student retention and academic success in the Mental Health Nursing course and Pre-Nursing programs (Anatomy and Physiology).

Presenter:
Dr. E'Loria Simon-Campbell – Assistant Professor, Coordinator of Retention & Progression, College of Nursing
Prairie View A&M University

Closing the Gaps in College Preparation: A Higher Education Perspective

Graduation standards at the high school level vary quite a bit from state to state. Despite increasing standards, many students are not prepared for college level requirements, needing either remediation or changing majors from STEAM to other disciplines. This presentation will cover the existing gaps between high school graduation and college preparation, compare U.S. standards with international standards, and provide recommendations for improvements based on cognitive development theories and project-based learning application. The presenter is the project director of a TMCF grant on high school reform and will share his experiences with the audience.

Presenter:
Dr. Anil Kumar – Professor, Electrical and Computer Engineering
Prairie View A&M University

Securing and Administering Faculty Research Grants

Description:
In 2011, with support from the U.S. Department of Energy, TMCF awarded $1.1 million in Minority Science Initiative grants. Hear from selected recipients as they detail the award process from start to finish, including the processes they used to develop and write their proposals, as well as the strategies they employed for budget management and progress reporting.

Presenters:
Dr. H. Banerjee – Professor, Biology, Elizabeth City State University
Research – Constructing Thermostable Celluloases to Produce Inexpensive Biofuels

Dr. Kiranmai Bellam – Assistant Professor, Computer Science, Prairie View A&M University
Research – Energy Conservation in Large Scale Storage Disk Systems

Dr. Jacob Oluwoye – Professor, Community Planning & Urban Studies, Alabama A&M University
Research – Development of LEGO STEM Transportation (LSTEM-T) Education Outreach Renewable Energy Initiative Projects in Minority Students K-12 Classrooms

Dr. M.A. Salam – Associate Professor, Computer Science, Southern University
Research - Enhancing a Secure Data Aggregation Algorithm for Wireless Sensor Networks

Dr. Ju Wang – Assistant Professor, Mathematics and Computer Science, Virginia State University
Research - Energy-Efficient Low Power Optical Communication for Remote Agricultural Applications

Tuesday, March 26

EXPANDING HORIZONS: PATHWAYS TO CAREERS IN STEAM

8:30 am – 10:00 am Morning Plenary

Joan Higginbotham, Former NASA Astronaut
Director, Community Relations, Lowes Companies, Inc.

10:15 – 11:30 Career Opportunities in STEAM:

STEAM Student Success and Retention: Incorporating Theory and Research-based Interventions

STEAM faculty and the National Science Foundation have expressed concerns about the lack of retention of African American students in STEAM majors. While national standards exist to supply these students with foundational skills and knowledge in order to plan and make decisions about their career paths, they are rarely implemented in the K-12 system with regard to career planning and decision-making. Thus, African American students often enter STEAM majors with stereotypical and limited understandings of their career options and necessary tasks to accomplish their career goals. Missing the link to clear career goals, it is far easier for students to drift away than to persist with the challenging tasks presented by these majors.

Based on a study funded by the National Science Foundation, this presentation will provide a summary of relevant theory and data on research-based interventions in Vocational Psychology that can be used to develop programs and support services to increase STEAM students' commitment to and retention in these important careers. A model intervention will be presented, with attention to the underlying framework comprised of career management skill development, advanced career field information exploration, culturally appropriate activities, and linkage to success in graduate school and employment.

Presenter:
Dr. Marie Hammond – Associate Professor of Psychology, Tennessee State University

Improving Student Aspirations to Study STEAM in College

Academic programs in science, technology, engineering, agriculture, and mathematics (STEAM) in state supported colleges and universities are at risk because of low productivity. Improving the preparation of secondary students in science and mathematics would significantly improve STEAM matriculation in college. In any industry, productivity is a function of the raw material used in to the manufacturing process and the quality of the process itself. Education as an industry and its processes need to be improved to produce graduates of quality. This does not mean simply increasing the courses in science and mathematics, but changing the focus to be student centered. If we do not have students, the input, we cannot produce graduates, the output. In the 1970s and 1980s, American industry was in a crisis of productivity and quality. Several major corporations were near bankruptcy and some went bankrupt as a result of the loss of markets because of the quality of their products. The quality movement developed to address these issues in business and industry with great success; however, its implementation in education has been very slow.

Come hear the presenter share ideas for the improvement of the quality of science and mathematics programs and students based upon his experience as a quality engineer in the software development industry and many years as a teacher of freshmen.

Presenter:
Dr. Oscar Criner, Professor, Computer Science, Interim Associate Dean, College of Science and Technology
Texas Southern University

The Road Less Traveled: Proof for Fermat's Last Theorem

Since Fermat postulated his now famous theorem, otherwise known as Fermat's last theorem, many have tried to construct the elusive proof. In 1993, Andrew Wiles proposed a proof, which made use of some amazing mathematical arsenal seemingly inaccessible to Fermat and his peers. In this session presenters will share a logical/algebraic cadre that can encapsulate a proof much more elementary than that of Wiles, but was probably more likely available to Fermat since he claimed to have himself a proof of the now famous theorem.

This presentation is intended to remind us that in effort to broaden participation into the STEAM disciplines, we may need to take the road less traveled and try things outside the accepted norms in order to capture and captivate the minds of the next generation of STEAM scientists.

Presenter:
Dr. Max Winshell Fontus, Assistant Professor of Chemistry
Prairie View A&M University

Cyber Security as a Pathway to STEAM Learning in Partnership with Small Businesses

Education for today's students requires both engagement and relevance. South Carolina State University is partnering with a small business to develop a program that will engage students beginning in K-12 through the undergraduate education in real world, hands-on problem solving to generate interest in STEAM, build the necessary skills for success in the STEAM fields and develop a workforce that is STEAM ready.

In this session, presenters will outline a comprehensive partnership strategy for the development of a STEAM pipeline, a STEAM ready workforce and STEAM researchers using Cyber Security as the model.

Presenters:
John Rosenthall – VP of Research, Economic Development & Public Service
South Carolina State University

Janet Simmons – CEO, IGlobal Security Solutions

Special Session (Member-School Presidents)

In 2012, TMCF was awarded a $3 million grant from the Department of Defense Air Force Office of Scientific Research (DoD-AFOSR) to establish and expand upon programs that provide access to students for civilian and non-civilian opportunities that require highly skilled talent in Science,

Technology, Engineering, *Agriculture*, and Mathematics (STEAM). In this special session, TMCF will share with member-school presidents its capacity building strategy for leveraging international relationships to expand opportunities in research and student exchange.

Presenter:
Dr. N. Joyce Payne, Founder
Thurgood Marshall College Fund

ENSURING LEGACY: THE CALL TO ACTION

12:00 noon – 1:30 pm Afternoon Plenary

Johnny C. Taylor, Jr.
President & CEO
Thurgood Marshall College Fund

1:45 pm – 3:00 pm Roundtable Discussions (Concurrent)

During these closed-door discussions, participants will engage with their peers in solutions-based dialogue related to the strengths, barriers, opportunities, and next steps for increasing student retention, graduation and career readiness in STEAM fields.

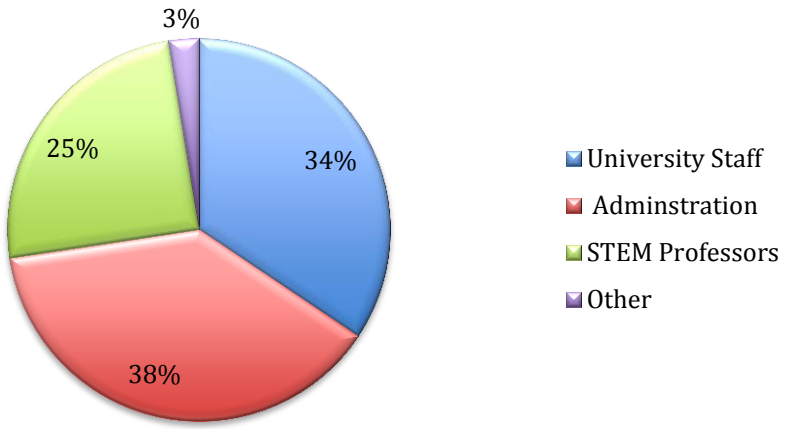
- University Presidents
- Deans/Department Chairs/Provosts
- Faculty/Researchers

6:30 pm – 8:00 pm Closing Reception

Participants

MUPI is an invitation-only conference, connecting 157 registrants from 43 TMCF member-schools. TMCF invited persons with direct decision-making authority related to STEM curriculum, research, fundraising, retention, and graduation (e.g., administrators/faculty). As shown in figure 1 below, institute attendees represented a range of participants including **administrators** (presidents, provosts, deans, department chairpersons), **faculty** (STEM professors, researchers), and **university staff** (career service, retention service, grants and advising).

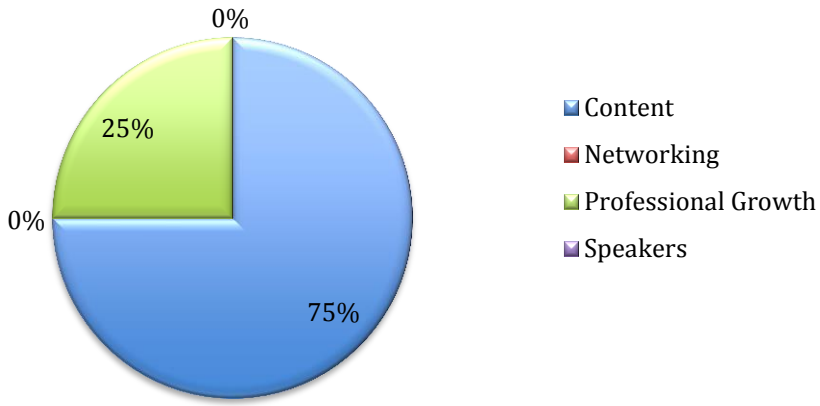
MUPI Participants



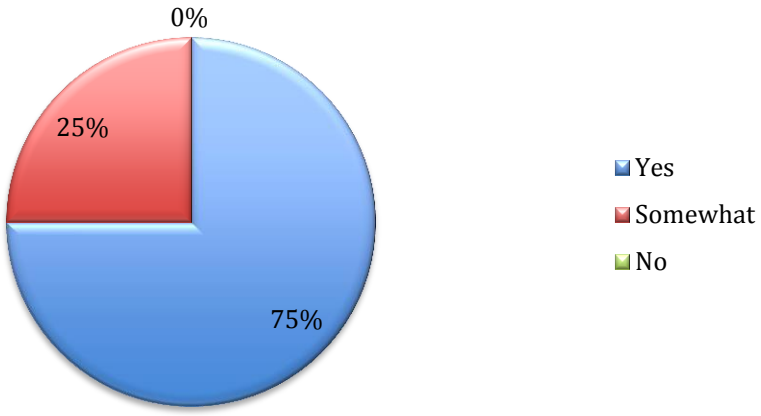
To determine the views of attendees with direct decision-making authority, TMCF asked presidents, provosts, researchers, professors, deans and department chairpersons to complete a post-institute survey. The response rate was 54%.

Institute survey data suggest that participants were satisfied with the institute. Of note was the percentage of participants who felt that the information they learned could be immediately used at their institutions.

Reason for Attending - Presidents

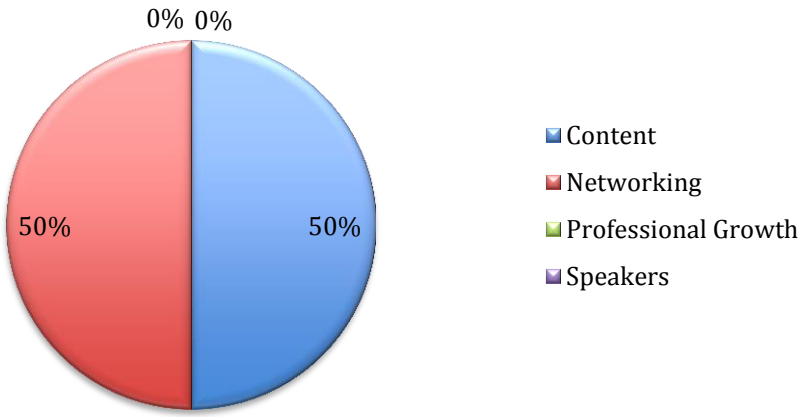


Met Reason for Attending - Presidents

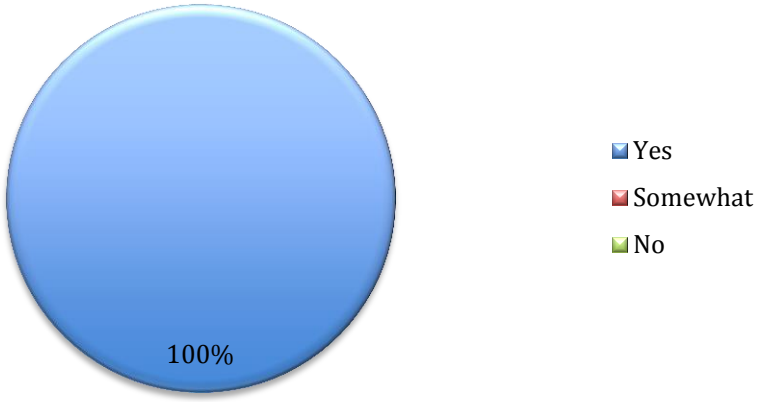


	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	75%	25%			
Registration Process	100%				
Venue	100%				
Food & Beverage	50%	25%			25%

Reason for Attending - Provosts



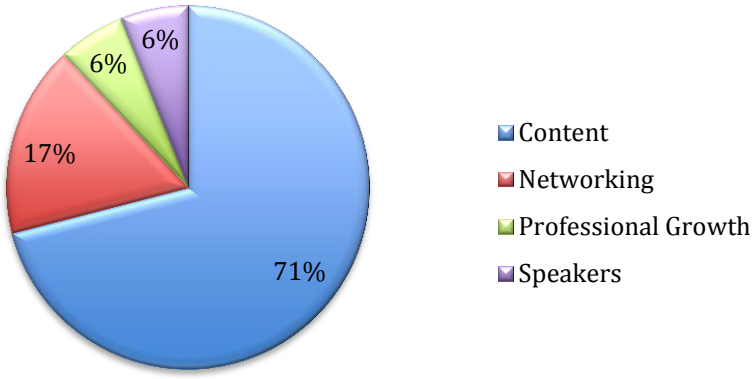
Met Reason for Attending - Provosts



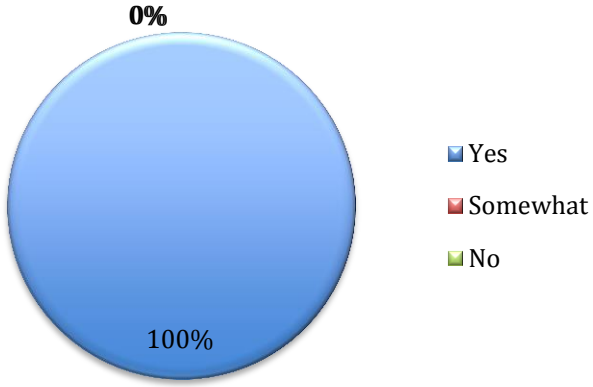
Overall Satisfaction - Provosts

	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	100%				
Registration Process	100%				
Venue	100%				
Food & Beverage	100%				

Reason for Attending - Professors



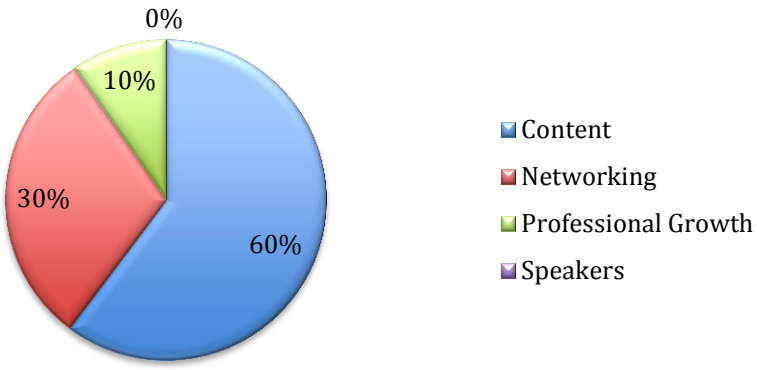
Met Reason for Attending - Professors



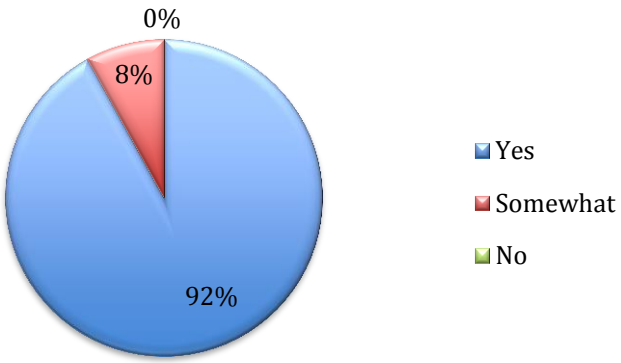
Overall Satisfaction Professors

	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	100%				
Registration Process	94%	6%			
Venue	94%		6%		
Food & Beverage	76%	12%	6%		6%

Reason for Attending - Deans



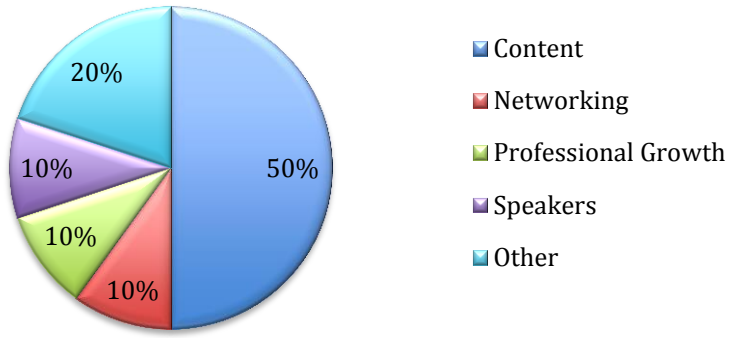
Met Reason for Attending - Deans



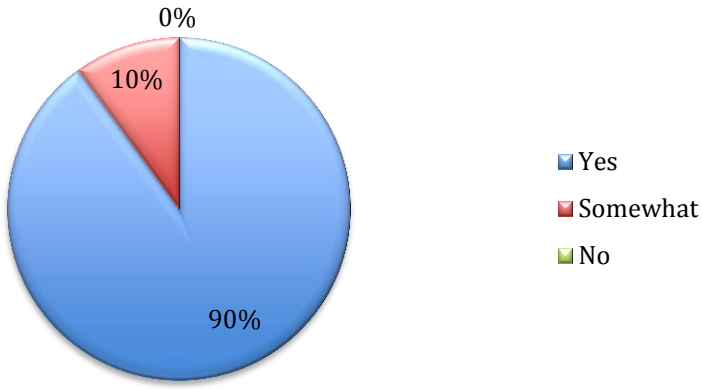
Overall Satisfaction - Deans

	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	92%	8%			
Registration Process	92%	8%			
Venue	100%				
Food & Beverage	75%	25%			

Reason for Attending - Dept. Chairs



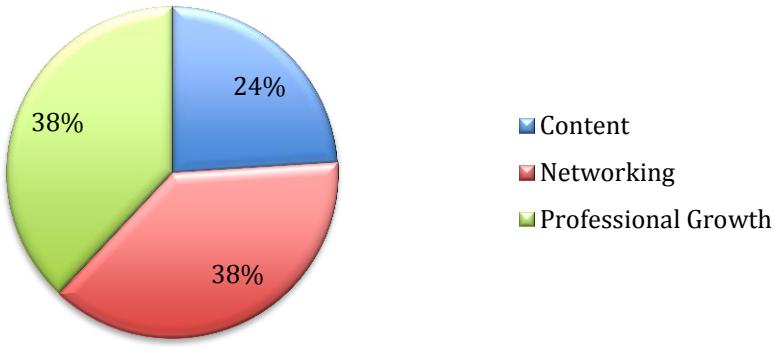
Met Reason for Attending - Dept. Chairs



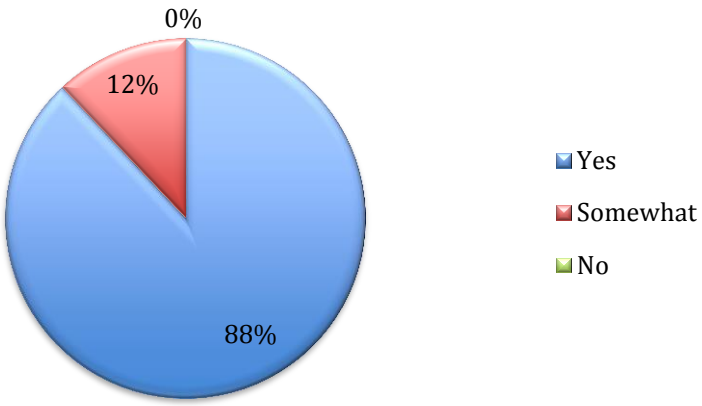
Overall Satisfaction - Dept. Chairs

	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	80%	20%			
Registration Process	100%				
Venue	90%			10%	
Food & Beverage	60%	40%			

Reason for Attending - Researchers



Met Reason for Attending - Researchers



Overall Satisfaction – Researchers

	Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied	Dissatisfied
Conference Content	88%	12%			
Registration Process	100%				
Venue	100%				
Food & Beverage	100%				

II. Expanding STEM Research

TMCF identified and supported STEM research activities a five TMCF member-schools that paired undergraduate and graduate students with experienced faculty. The goal is to develop a pipeline of research talent who attain PhDs in DOD AFOSR mission critical STEM fields.

When students participate in undergraduate research, their confidence increases and they develop expectations of earning a Ph.D[4]. During TMCF's 2014 Member Universities Professional Institute, the principal investigators will share each project as replicable models to help TMCF's entire member-school network increase its undergraduate research capacity. The ability to track the experiences of undergraduate students who engage in research will allow departments, colleges, and universities to make adjustments and monitor for improvement. The information will help institutions make decisions regarding programmatic offerings and formulate funding requests.

Purpose

The purpose of the project was to determine the types of **undergraduate research experiences** that lead to student retention and graduation in STEAM fields, including the *characteristics of students* who pursue undergraduate research coupled with the research exposure they receive.

Awarded institutions used the grant resources to (1) provide research opportunities to undergraduate STEM students; (2) document the research process (i.e., student selection, training, mentoring and laboratory work); and (3) design tools to track participating students' matriculation from their research experience through graduation. Four of the participating schools requested no-cost extensions until December 15, 2013. Final reports from participating schools are included below.

Delaware State University
Principal Investigators: Vasudevan Ayyappan, Venu (Kal) Kalavacharla
Project Title: Collaborative Undergraduate Experiential Training in Epigenomic Research (CUET-ER) in the Common Bean

Abstract

Integrating research experiences into classroom teaching, and use of practical laboratory and field-based examples is of great benefit. Through research experiences, students are provided opportunities that enrich their understanding of research-based sciences, help them define science careers, and generate interest in graduate studies research. The positive effects of an undergraduate research experience on student learning, attitude, and career choice have passed from anecdotal to systematic data. The general benefits include student-reported gains on a variety of disciplinary skills, research design, information or data collection and analysis, information literacy, and communication. Undergraduate research experiences are a well-established approach to providing independent research experience where students conduct their own research under individual faculty member's/mentor's laboratory. It is important for undergraduate students at Delaware State University (DSU), an 1890 land-grant Historically Black University (HBCU), Delaware Technical and Community College (DTCC), and Wesley College (a minority serving institution) to obtain

[4] Russell S, Hancock MP, McCullough J (2007). Benefits of undergraduate research experiences. Science 316, 548-549.

positive research experiences that guide them toward pursuing terminal degrees in their respective fields of interest. In order to achieve this goal, faculty will train undergraduate students from DSU and partner institutions who will be motivated and supported so that they secure tools necessary for education and careers in Science, Technology, Engineering, Agriculture, and Mathematics (STEAM) fields. In this project, students will be trained in the comparative analyses of molecular and epigenetic variation in greenhouse and in vitro cultured common bean plants as tissue culture techniques are becoming increasingly popular as an alternative means of plant vegetative propagation. As more accurate and powerful tools for epigenetic analysis become available for application in a broader range of plant species, analysis of the epigenetic landscape of plant cell cultures may turn out to be crucial for understanding variant phenotypes.

Progress

- Plants have been grown in MS media.
- Plants have been grown in a traditional soil setting.
- Phenotypic observations have been made comparing the plants grown in soil and the plants
- grown in MS media
- Leaf samples from green house grown plants and in vitro grown plants were collected and
- stored at -80ºC
- Three TMCF supported undergraduate students worked closely with each other as well as
- with other members of Molecular Genetics and Epigenomics Laboratory (MGEL), as well as with other students recruited nationwide in other programs supported by Center for Integrated Biological and Environmental Sciences (CIBER)

Lessons Learned

Before this project, the student researcher had only conducted tissue culture one other time in a biotechnology course, using an orchid. Through this study, the researcher became more proficient in aseptic technique, learned how to create tissue cultures from seeds, and found out to care for these plants grown in media. The researcher also read papers that discussed past experiments involving tissue culture and ChIP sequencing techniques and learned what types of applications these two technologies have had in the past, as well as, what plants have been involved in studies similar to the one the team was conducting. It was only through trial and error that the researcher was able to finally learn how to properly cut apart, plant, and care for these subcultures; many seeds just died and the researcher had to constantly plant more batches of seeds because the previous batch had all died or had been found to have some type of contamination and had to be disposed of. From this experiment, the researcher also learned what phenotypic differences would occur between plants that were grown in MS media and plants that were grown in soil. These phenotypic differences include size of leaves and length and thickness of roots. The researcher hadn't really considered it before, but it makes sense that the leaves and roots weren't particularly large in MS media cultured plants. There is no need for the plants to have a large surface area to soak up sunlight, because there is more than enough artificial light coming from the incubator. There is also no need for the roots to grow deeply and complex because the plant doesn't have to stabilize itself within soil to prevent being washed or blown away by natural forces. The MS media is also packed with nutrients and everything else that the plant needs for survival, so there is no need for the root system to spread out or widen its surface area. The researcher discovered that there exist genes that cause and/or 3 control the expansion from leaves and roots in plants that are

grown in soil, which can be turned on or off depending upon the current needs of the plants.

Challenges

The main challenge of this project was trying to prevent contamination. Every once in a while, the research team observed bacterial contamination within the subcultures, but this was easy to fix; researchers just used a more copious amount of ethanol-iodine mixture on the instruments and surfaces, which the team then cleaned more frequently. The lab with the clean bench, in which the subcultures were created, had recently experienced a large amount of fungal contamination spanning several different projects. The team combatted this form of contamination with special anti-fungal detergent wipes that the lab ordered specifically in response to this contaminate.

Dissemination Plan

The plants sub-cultured in MS media are very different from the plants that are grown in soil. The sub-cultured plants are relatively short in stature compared to soil-grown common bean plants, as if the growth of their extremities had been hindered or deemed non-essential to the further development of the plant itself. The leaves from the sub-cultured plants are significantly smaller than leaves on the plants grown in soil. The root systems of these sub-cultured plants are also not as complex and extensive as the plants grown in soil. These leaf and root features might have been changed because the plant did not need them to be as extensive as they usually are in order to survive.

Student Outcomes

The undergraduate students for the most part had never done any tissue culturing. The principal investigators had them study several research papers in which an experiment had called for tissue culturing so that they would learn about applications for tissue culture in the scientific community. They also read about the benefits of ChIP-sequencing (ChIP-seq) and why it is such a revolutionary piece of technology used in many other biological systems including mammalian research. This was an entirely new experience for them and they learned all of the intricate steps of performing tissue culturing such as how to make media, how to prepare seeds, and how to plant the seeds within the media. The students became acclimated to using aseptic technique and learned which types of contaminates they were likely to observe and how to combat certain ones.

Next Steps

The next step in this project will be ChIP-Seq of common bean leaves collected from in vitro grown plants as well as soil grown plants. Data from ChIP-Seq would potentially determine differences in chromatin modification and would thereby indicate whether key genes have potentially been turned on or off as a result of a particular histone modification. The research team wants to determine what these genes are and learn why they are essential to the plant.

Florida A&M University

Principal Investigator: Subamanian Ramakrishnan

Project Title: Structure-Property Relationships in Ploymner Grafter Nanoparticles: Toward Novel Nanocomposites for Defense Applications

Abstract

Nanoparticles and their mixtures have emerged as critical technology enablers for a wide range of aerospace and commercial applications, including pulsed power capacitors, multifunctional composites and active layers for energy harvesting devices. In these applications, control of nanoparticle arrangement and distribution is a critical factor determining the final processing and property suite. Air Force Research Laboratory (AFRL) has recently demonstrated a new nanocomposite concept in which the polymeric matrix is molecularly attached to the nanoparticle during the initial process of nanoparticle synthesis. The single phase nature of these hybrid nanoparticles avoids issues of compatibility, agglomeration and phase separation during processing, and provides routes to control nanoparticle arrangement if physics-based correlations between the structural characteristics of this polymeric corona and the structure and dynamics of the final hybrid nanoparticle assembly could be determined. The aim of this proposal is to provide this critical insight by utilizing newly developed scattering techniques (at Argonne National Labs - ANL) to experimentally measure the structure and dynamics of polymer-grafted nanoparticles from isolation to dense assembly. Using these measurements the researchers will establish the correlation between polymer graft density and molecular weight with polymer corona entanglement, structure and macroscopic processibility. Such composites will not only have high loadings of particles but at the same time be amenable to processing and maintain their properties (durability) over longer periods of time over current technologies. Research plans over summer will be tightly coupled with education of undergraduate students (African American) at Florida Agricultural and Mechanical University (FAMU) who will accompany the principal investigator to the national labs (ANL and AFRL). The project will play a key role in the education of these students in the area of materials and expose them to state of the art research. Work will be continued at FAMU during fall of 2013 with the help of the students thus keeping them involved in the science. The participating student's matriculation from the research experience to graduation will be monitored and the students will be encouraged to pursue graduate studies.

Project Overview

The goal is to understand the structure function relationships in particle-polymer composites in order to develop useful materials for the department of defense. The team is currently using X-ray Photon Correlation Spectroscopy (XPCS) at Argonne National Labs in collaboration with Dr. Alec Sandy to study the structure and dynamics of nanoparticles in poymer melts. The goal is to couple these measurements with rheological measurements (to study flow properties) back at FAMU to elucidate structure-function relationships in these materials.

The overall goal is to develop a Nanoscience and Nanotechnology research program at Florida A&M University which will greatly aid in the research and education of minority students at FAMU. The proposed projects of Dr. Ramakrishnan and Dr. Mochena are the first steps in this direction. With the polymer grafted nanoparticle project the aim is to understand the physics-based correlations between the structural characteristics of the polymeric corona and the structure and dynamics of the final hybrid nanoparticle assembly with an aim of producing useful structures for

air force applications. The infiltration of nanomaterials of interest into porous media will lead to functional materials of interest to the army.

Progress

- Dr. Ramakrishnan spent time at Air Force Research Labs in learning the synthesis of polymer grafted nanoparticles and techniques to characterize them. Back in the labs at FAMU – he is working on setting up characterization equipment to continue the work. ***He just received notice from DOD (11/26/2013) that his equipment grant ~$430,000) was recommended for funding.*** This will greatly aid in setting up the facilities in FAMU. This grant was written while at AFRL over summer.

- Dr. Ramakrishnan, Crystal Lipscomb (freshman) and Amber Porter (junior) spent time (8 weeks) at Argonne National Labs (ANL) in developing X-ray scattering techniques to characterize the polymer grafted nanoparticles – a great research and educational experience for students. Amber and Crystal are currently working in Dr. Ramakrishnan's lab on the research and analyzing data collected over summer.

- Carissa Redmon is working on her honors thesis on structure and rheology of colloidal gels.

- This is the first time that someone has measured the dynamics of hairy nanoparticles at Argonne National Labs systematically as a function of different parameters.. ***Dr. Ramakrishnan will spend the summer of 2014 at Argonne National Labs working on these experiments.***

- Carissa, Crystal and Amber will be presenting the results of their summer work at the National Society of Black Engineers conference in Sprung 2014 after working in Dr. Ramakrishnan's lab in Fall 2013.

- A new course titled – " Nanoparticle Synthesis and Characterization" ***will be offered for the first time at FAMU during Spring 2014 –by Dr. Ramakrishnan***. This will be lab/theory course offered at the National High Magnetic Field Laboratory and the results of the projects will be presented as modules in the course. Funds from this grant were used to set up a fume hood – critical for functioning of the lab an offering of the course.

- Numerical simulation of the partial differential equation governing the concentration of nanomaterials with respect to position and time was performed. A poster presentation of the results was given at the Eletrochemical Society Conference in San Francisco in October, 2013.

- Ab initio molecular dynamics calculation of the electronic and geometric structure of the nanomaterials was done. A poster presentation of the results was given at the Eletrochemical Society Conference in San Francisco in October, 2013.

Lessons Learned

Dr. Mochena

Using ab –initio molecular dynamics, the research team optimized Cd_nSe_n for n=33, 45, 81. The results of Cd_nSe_n, n=33, 45, and 81 show that $Cd_{33}Se_{33}$ is substantially distorted from input structure, which is cut out of the bulk structure. The number of quadruply bonded atoms of $Cd_{33}Se_{33}$ is the largest, however, nearly 50 % of the Cd atoms have Cd-Cd bonds. This is the manifestation of the significant distortion that $Cd_{33}Se_{33}$ undergoes and not the result of the stability of the interior region relative to readjustment of the surface atoms arising out of the finiteness of the structure. $Cd_{45}Se_{45}$ shows slight distortions and is on the borderline of structures that are evolving according to the team's premise of tetrahedrally coordinated interior region surrounded by surface atoms with less bonds. Clearly $Cd_{81}Se_{81}$ shows the least amount of distortions and is very close to the input structure. In all of these structures, a significant number of Cd-Cd bonds exist. Therefore, to achieve more tetrahederal coordination either the nanoparticles have to be grown at finite temperature that supplies enough thermal energy that would break up the Cd-Cd bond or be deposited at finite temperature that could also lead to break up and rearrangement of bond order. These results, however, must further be verified by electronic density and charge density plots. The research team is currently verifying the bond formation and then will heat up the system and find out the effect of temperature.

Dr. Ramakrishnan

Synthesis and characterization of functional nanomaterials require more stringent standards than normal operating conditions. The goal is to stick to these standards back at FAMU in transferring the technologies from AFRL.

X-ray Photon Correlation Spectroscopy (XPCS) is a valuable tool to study the dynamics of nanoparticles. The team successfully used XPCS as a tool to study the structure and dynamics of the hairy nanoparticles at Argonne National Labs. The team has obtained initial data, which clearly shows that upon increasing the polymer molecular weight attached to the nanoparticle, the dynamics of the particles are speeded up at temperatures above the glass transition. The team is in the process of using this data to apply for more experiment time at Argonne. **The initial data also helped Dr. Ramakrishnan procure an equipment grant from DOD.**

The team continued analyzing the data collected at Argonne during Fall 2013 with the help of Amber and Crystal who accompanied Dr. Ramakrishnan to Argonne.

<u>Challenges</u>

Dr. Mochena - None

Dr. Ramakrishnan – Experiments on the hairy nanoparticles were performed for the first time at Argonne. A number of challenges as to how to load the samples, how to interpret the results were faced. The team solved the sample loading problem by working with beamline scientists and different sample holders. Interpreting results is still an issue. The team is working closely with beamline scientists at Argonne, and also has a theorist on board (Dr. Shanbhag at Florida State University) – who is modeling the experimental data. Hopefully this will provide some microscopic insights into the dynamics.

<u>Dissemination Plan</u>

Dr. Mochena

1) Presented two poster presentations at the Electrochemical Society conference, October 27 – November 1, 2013 in San Francisco.

2) The work involving ab initio molecular dynamics was submitted to Journal of Applied Physics and is being revised for re-submission taking into account the referee's comments.

Dr. Ramakrishnan

1) Amber Porter and Crystal Lipscomb will present the work over summer at National Society for Black Engineers conference during spring 2014.

2) Carissa Redmon will work on a honors thesis which will involve data analysis of the data collected at Argonne.

3) Dr. Ramakrishnan will present the results at a conference during spring 2014.

4) The team is working on modules based on the team's research, which will be presented in *the Nanoparticle Synthesis and Characterization* course which is to be offered during spring 2014.

Student Outcomes

Dr. Mochena

The undergraduate students were involved in different ways. The research team had a weekly meeting where the two professors (Prof. Elijah Johnson and Prof. Mogus Mochena) presented results of their respective groups. The students attended these meetings and were exposed to creation of a model to handle the problem and to the quantum mechanical software to compute the problem. The students were taught how to solve partial differential equations numerically. Prof. Johnson wrote a C-program and the students had to go over it. The students helped with analysis of bonds of the results of ab initio molecular dynamics.

Dr. Ramakrishnan

Amber and Crystal had a very rewarding experience at Argonne National Labs. Amber was a Junior while Crystal was a freshman. Argonne initially is overwhelming for students - Xray scattering is a difficult concept to understand even for graduate students. The faculty researcher spent time every day with the students explaining to them the project and how the students would be using X-rays to characterize the materials. Both of them understood the process of research – the process of planning for experiments, preparing samples, performing the experiments and then data analysis. Amber and Crystal are now helping me continue the experiments and analysis back at FAMU.

Next Steps

Dr. Mochena

The research is continuing. The faculty researcher is planning to get one of the students from last summer into the graduate program (his GPA is below the requirement). If successful, the student will have a Ph. D dissertation research work ready to work on. The researcher intendes to study the problem with classical molecular dynamics using the software LAMMPS.

Dr. Ramakrishnan
1) Awarded DOD grant will greatly aid in continuing work at FAMU. 2) Amber, Crystal and Carissa are working on research projects 3) The researcher went back to Argonne in Nov 2013 for more experiments and will spend summer of 2014 at Argonne as well to continue working on the project, and will take two undergraduate students to participate.

Lincoln University (PA)
Principal Investigator: Derrick Swinton
Project Title: 2013 Summer Residential Research Experience for the Ethnically Under-represented Students in STEAM Disciplines

Abstract

An eight week residential summer research experiences for six undergraduate students with majors in any of the Science, Technology, Engineering, Agriculture & Mathematics (STEAM) disciplines, on the campus of Lincoln University, commonwealth of Pennsylvania, the first degree-granting HBCU, is designed to expose prospective TMCF Scholars to very active and comprehensive supervised research activities in the following disciplines: Agriculture (Plant Science), Biology, Bioinformatics, Chemistry, Computer Science, and Mathematics.

At the end of the eight-week summer residential research experience program, the following research objectives will be achieved:

a) Develop a holistic understanding and appreciation of critical factors, based on locus of control research and attribution theorem, that have significant influence in determining, actualizing, and sustaining desired behavioral and performance outcomes in STEAM disciplines — to include active persistence or retention, high academic achievements, and placement in graduate and professional schools.

b) Identify and describe the characteristics of undergraduate students who participate in supervised research activities.

c) Identify and describe the type of research experiences that have significant influence on students' behavioral and performance outcomes in higher education environments.

Based on participation in the eight weeks summer residential research experience in STEAM disciplines at the Lincoln University, TMCF Scholars will:

- develop hands-on-experiences on how to successfully conduct research projects;
- understand the ethical and responsible conduct of research — using humans and animal subjects;
- develop practical approaches to the functional role of self and the power of significant others in predicting and actualizing desired and sustained outcomes;
- actively participate in non-academic activities that build strong and collaborative learning communities;
- present the processes and outcomes of their research projects at local meetings and national conferences.

Progress

- Six TMCF Research Scholars participated in 8 weeks of undergraduate summer research activities on the campus of The Lincoln University, alongside faculty researchers or faculty research mentors.
- All student researchers took a national "Preflection Survey" or pre-assessment of their prospective participation in Summer Experience in STEM projects (www.grinnell.edu/academic/csla/assessment/sure).
- Each week, on Tuesday and Thursday, Scholars attended professional development workshops/learning communities, having a range of topics that included the following:

    - Ethical and Responsible Conduct of Research
    - Preparing for graduate school (GER/MCAT/DAT/PCAT Exams)
    - Career choices in STEAM disciplines
    - Factors influencing desired and sustained learning outcomes
    - Impact of social media in choices and decisions
    - Understanding financial planning

- Certificates of Successful Accomplishment, signed by the PI, the Dean of the College of Science and Technology, and the Senior Vice President of Academic Affairs, were presented to each of the 6 TMCF Scholars during a campus-wide closing ceremony. Please refer to attached group photograph.
- All 6 TMCF Scholars prepared and presented PowerPoint presentations of their research process, results, and recommendations for continuing work during the academic year. Five students participated in poster presentations at the Annual Lincoln University Science Fair held in October. Two students made poster presentations at the Annual Biomedical Research Conference for Minority Students (ABRCMS) held in November in Nashville, Tennessee.
- All 6 TMCF Scholars completed the national post-assessment, "SURE III", for active engagement in Summer STEM and related research projects. (www.grinnell.edu/academic/csla/assessment/sure).

Lessons Learned

The primary lessons learned by the Principal Investigator, student researchers, faculty researchers, project manager, and staff of the Office of Research & Sponsored Programs are as follows:

a) Plenty of time is needed to recruit, select, and enroll prospective students for active engagement in residential summer research experiences.

b) Participation in the planned research projects for undergraduate students requires a strong commitment of time, effort, and resources to ensure desired and sustained outcomes.

c) Faculty mentors must be available and readily accessible to meet daily and consistently with each student researcher.

d) Student researchers must have strong working knowledge and skills in research methodology before assignment of specific activities in the labs.

e) Success of the summer residential program must be carefully and consistently coordinated with staff of Residential Life, Food Services, Campus Safety, Business Services, Academic Success Center/Learning Resources Center, Student Researchers, Faculty Research mentors, appropriate university administrators.

f) Needed materials and supplies for individual research lab must be coordinated with purchasing department, at least three weeks before the start of the research experiences, to ensure accurate and timely processing and delivery**.**

Challenges

Because the LU faculty and staff managed summer bridge programs in the past, the challenges experienced during the program were not major and were addressed as the program progressed. However, this was the first time LU faculty and staff managed a summer REU program. This program yielded a unique set of challenges, including:

- Having a system in place to ensure research supplies were ordered prior to the start of the program. This was addressed by working closely with the purchasing department and business office.

- Ensuring that budgeted items were expended correctly. The business office assisted in setting up an account that was easily managed by the PI and sponsored program office.

Dissemination Plan

An announcement of the award was published in the ***Lincolnian***, a university publication that is distributed to the Lincoln University community, including alumni and the local community. The announcement was also published in ***The CATALYST***, a quarterly newsletter published and circulated by LU's Office of Research and Sponsored Programs. Because funds were used from NSF grants to leverage support for the students and mentors, the activities of TMCF were presented in LU's Annual HBCU_UP report. Information was also disseminated to students arriving this academic year, so that they can learn more about the TMCF and its supporting activities. Finally, a university/STEAM program booklet is being developed that will include the LU TMCF Scholars, Faculty Researchers/Mentors, and appropriate university administrators. This publication will be widely distributed amongst the scholars, academic leadership, and others in continuing efforts to use the TMCF Summer Research experiences to institutionalize Research Experience for Undergraduate (REU) students at The Lincoln University.

Student Outcomes

The students participating in the program had limited laboratory and research experience. Based upon feedback from the students and faculty advisor it is clear that the students progressed in their basic understanding of science and research. The following key skills were taught and are key areas that the students made significant progress:

- The role of research
- Development of a research strategy and writing of a research plan
- Documentation of research results

- Presentation and publication of research results (poster and oral presentation)
- How to conduct literature searches and interpret scientific articles.
- The role and purpose of IRB
- The connection between theoretical concepts learned in the classroom and applications.
- Improved their critical thinking and independent learning skills

Next Steps

The research team is developing a proposal to submit to the NSF to establish an REU program at LU. The team will use learned and best practice from this experience to guide the management and implementation of the LU REU Program.

Norfolk State University

Principal Investigators: Sandra J. DeLoatch, Ashley Neal Haines, Zenora Spellman
Project Title: Beyond the STARS: Extended Research Experiences for Undergraduates in STEAM

Abstract
Streptococcus parauberis is a gram-positive, lactic acid bacterium that causes mastitis in dairy cattle and streptococcosis in fish. This species is an emerging pathogen that is poorly understood and its pathogenomics are not well studied. Previous research has shown that pathogenic and non-pathogenic strains exist in both cattle and fish hosts. The goal of this project is to identify genes that may contribute to the virulence of this pathogen and its ability to emerge in new host species. Norfolk State University (NSU) is a Historically Black University that serves approximately 7,100 students of which 1,056 are currently enrolled in the Departments of Biology, Chemistry, Computer Science, Engineering, Mathematics, Physics, and Technology in the College of Science, Engineering, and Technology (CSET). In 2001, the School of Science and Technology (now the College of Science, Engineering, and Technology or CSET) at NSU developed a robust program encompassing undergraduate recruitment, pre-entrance preparation, advising, mentoring, research, and curriculum development to address the low graduation rates of students of historically underrepresented groups. This project called STARS (Science and Technology Academicians on the Road to Success) was funded by the National Science Foundation under its HBCU-UP Program.

The centerpiece of STARS is the STARS Office, whose goal is the consolidation and enhancement of all existing programs and the creation of new components to provide the Science, Technology, Engineering, and Mathematics (STEM) students with a seamless environment of recruitment, pre-entrance preparation, advising, mentoring, and research. The hypothesis is that such an environment will significantly increase the success rate of STEM undergraduates at NSU. The STARS Project focused primarily on recruitment, transition from high school to college, and the first year of college matriculation.

Project Overview

The Norfolk State University's (NSU) Beyond the STARS: Extended Research Experience for Undergraduates in STEAM project participants compared the genomes of six strains of S. parauberis and addressed the following research questions:

- What genetic differences exist between strains of S. parauberis from mammalian hosts (cattle) and those from non-mammalian vertebrates (fish)?
- Do these genetic differences facilitate significant metabolic changes associated with moving from a homeothermic (warm-blooded) host to a poikilothermic (cold-blooded) host?
- Are these genetic differences associated with mobile genetic elements such as plasmids or, alternatively, with gene mutation?

What genetic differences exist between virulent strains of S. parauberis and avirulent (commensal) strains of S. parauberis? Are specific virulence genes or pathogenicity islands involved? Are these virulence factors the result of horizontal gene transfer, gene duplication or mutation?

Data collected will help the research team understand why this bacterium is emerging as a pathogen in new hosts, such as fish in the Chesapeake Bay, and work toward future control and vaccine development.

Progress

June 2013 – July 2013

- Sent out DNA for sequencing at University of Texas, Austin's Genome Sequencing and Analysis Facility (GSAF).
- Reviewed project background/goals with students and disseminated job assignments.
- Reviewed lab safety, basic pipetting technique and proper storage and handling of key reagents.
- Trained students on use of the gene sequence analysis software (Geneious 6.1.2).
- Received data from GSAF and have completed the first draft of 3 complete genomes as well as plasmids (13 contigs, 17 contigs and 23 contigs respectively).
- Identified regions with repeating elements that are difficult to place in the assembly and began analysis of repetitive elements (data suggest primarily tRNAs and rRNAs).
- Have begun BLAST analysis of potential plasmid genes, in particular search for the repb plasmid replication initiator gene and any virulence genes. The team is working with collaborators at Old Dominion University regularly to analyze this data
- Students presented their initial findings at the Bowie State University WBHR-LSAMP Summer Research Symposium in July 2013.

August 2013 – December 2013

- Genome Assembly: A second draft of the genomes was completed using Celera software which produced fewer used reads
- SHRMIP Analysis: SHort Read Mapping Package used to map short reads from next generation sequence data to a donor genome and identify polymorphisms. Data collected allowed us to analyze base-by-base differences in gene sequence that lead to changes in amino acid sequences and compare them across all the genomes analyzed.
- Core Genome Analysis: Six genomes were compared to establish the core genome for the species using an open source program called PanSeq (Laing et al. 2010). This program identifies the genes that are common for all strains, those genes that are shared by more than one strain, and finally those genes that are unique to any one strain. The core genome, based on current analyses, is ~1.6Mb of the ~2.1Mb total genome size.
- RAST Annotation**:** Rapid Annotation using Subsystem Technology (RAST) is an automated software tool used for annotating bacterial genomes. This places labels on all genes found within the set of databases and includes their putative functions.
- Plasmid Annotation: Geneious software was used by students to identify publically available gene sequences that match the plasmid they assembled and then add these annotations to the closed plasmid genome. This allowed the team to search for virulence

genes, transposons, and insertions sequences. Students learned about these mobile genetic elements and how they can be used to track bacterial evolution.

- New Manuscript Outline: The team has completed an outline for a new manuscript using the data collected under the TMCF STEAM grant. It will include all of the analyses listed above. The working title is: Evolutionary Implications of the Pan-Genome of *Streptococcus parauberis* and Closely Related Species. Authors: A.N. Haines, D.G. Gauthier, K. Thornton, A. Avent, I. Copeland.

Lessons Learned

The *"Beyond the STARS: Extended Research Experience for Undergraduates in STEAM"* grant provided participants with an array of new skills that include: 1) laboratory notebook guidelines, 2) basic scientific laboratory practices, 3) specialized scientific techniques and 4) molecular techniques such as DNA extraction, polymerase chain reaction, and gel electrophoresis. The students understanding of conducting research of the primary literature body, including performing electronic searches of journal databases, articles from open access journals, library databases, and Inter Library Loan services has increased greatly.

In addition, STEAM grant participants now have proficient bioinfomatics skills through their use of Genbank, BLAST analysis, ClustalW, Geneious 6.0.2, as well as other open access algorithms commonly used in bioinformatics. They understand how to create multiple sequence alignments, build phylogenetic trees, and annotate genomes. Their ability to understand and work with sequence data makes them immediately employable and qualified candidates for graduate school programs.

The students have had several opportunities to present their data (see below). Together, these experiences have given them considerable confidence regarding their knowledge of their research and their ability to communicate as scientists. In addition, they have completed multiple applications for travel and research grants; all students were awarded at least one grant for which they applied. This experience will be invaluable for building their future grant writing skills.

The above techniques and practices will assist STEAM interns in their academic careers, enhance employability, and contribute to their marketability as future graduate students in biomedical research laboratories. Together these lessons have motivated the students toward concrete plans for peer-reviewed publication. One intern is assisting with a manuscript currently in draft form that delineates three molecular typing schemes for *S. parauberis* using MLST, RAPD and PFGE. Three interns will be co-authors on a manuscript currently in outline form that will describe the pan- genome for *S. parauberis,* as well as the 16 kb plasmid now annotated. This manuscript will include much of the data gathered with the support of this grant. Finally, two of the interns are also assisting with preparation of a manuscript describing the capsule, surrounding *S. parauberis,* an important virulence factor.

Challenges

The primary challenge was not having the computing power to assemble genomes from collected data. Initially this process began at NSU; however, it was completed by collaborator Dr. David Gauthier at Old Dominion University. Using their facilities, students learned two main ways that genome assembly can be approached: de novo or a reference genome. Reference genome assemblies were completed at NSU, but ultimately de novo assembly provides the most complete data. This was a good learning experience for the students. It helped highlight the importance of collaborations and overcoming barriers to research.

Dissemination Plan

- STEAM participants have presented their research findings at the following conferences:
- Bowie State University WBHR-LSAMP Summer Research Symposium, Bowie, MD, July 9, 2013
- Virginia Academy of Science Undergraduate Research Meeting, Richmond, VA, October 26, 2013
- Virginia Branch of the American Society for Microbiology Annual Meeting, Charlottesville, VA, November 8-9, 2013
- Annual Biomedical Research Conference for Minority Students, Nashville, TN, November 13-16, 2013

Students project titles were: "The Master of Disguise: Analyzing Capsule Genes In *Streptococcus parauberis*," "Phylogenetic Analysis of *Streptococcus parauberis*," "Defining the Newly Discovered Plasmid in *Streptococcus parauberis*," and "Analysis of Potential Virulence and Host Specificity Genes On The Newly Discovered Plasmid of the Emerging Pathogen *Streptococcus parauberis*."

Student Outcomes

As researchers under the STEAM grant, students grew as scientists in three major ways. First, they learned about working with bioinformatics data. They appreciate how much data is generated by a project like this and the importance of having good computer resources for analyzing the data as well as protocols in place for managing and backing up the data. Second, their experiences presenting at scientific conferences have improved significantly since their practice presentations with the STARS Summer Research Program. As a result, several awards were granted to include: an undergraduate research grant from the Virginia Academy of Science and the 2014 Travel Grant to present at the National Emerging Researchers Conference in Washington D.C. Finally, their growth

as professionals has exceeded all expectations. Their ability to work together, provide critical feedback, support, and hold each other accountable to deadlines are excellent indicators of the future scientists they will become. In addition, they are motivated by seeing their efforts rewarded through recognition for their hard work. Together these experiences will make a significant difference in the future career track of these four minority students.

Next Steps

The students are continuing their research in preparation for presenting at the upcoming Emerging Researchers National (ERN) Conference in Washington, D.C. in February 2014, the National Institute of Science/Beta Kappa Chi Joint Meeting in Houston, TX in March 2014 and the American Society for Microbiology General Meeting in Boston in May 2014. They are also preparing applications for undergraduate research grants through ASM and other sources. The students will continue to work on the projects through the spring semester with the goal of finding summer research stipends. This summer will be used to prepare manuscripts for submission to peer-reviewed journals.

ARCHIVAL PUBLICATIONS (PUBLISHED) DURING REPORTING PERIOD: None

CHANGES IN RESEARCH OBJECTIVES, IF ANY: None

EXTENSIONS GRANT OR MILESTONES ALIPPIED, IF ANY: None

CHANGE IN AFOSR PROGRAM MANAGER, IF ANY: There was not a change in the AFOSR Program Manager, but there was a change in the Thurgood Marshall College Fund's Program Manager/Principal Investigator.